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THE
DREDGER
"CHIEN SHE"

(1936)

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FOREWORD

The following report provides a brief statement as to the factors which controlled the design of the dredger "Chien She", followed by a rather detailed description of the vessel itself.

The latter part of the report was drafted by Mr. William Smith, M. Inst. N.A., Dredging Engineer, who also supervised the vessel during construction.

At the same time I wish to record my indebtedness to the late Mr. J. G. Irvine, Mr. W. Smith, Mr. P. N. Fawcett, M. Inst. C.E., and Mr. J. Kolkmann (Technical Director to F. Schichau, G.m.b.H.) in various matters affecting the design of the ship.

During the first year the vessel was operated by Capt. J. Johannsen and Engineer H. Arndt, whose experience in drag dredging was of great value.

HERBERT CHATLEY.
Engineer-in-Chief.

Shanghai, Sept. 1st, 1936

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Plate I.

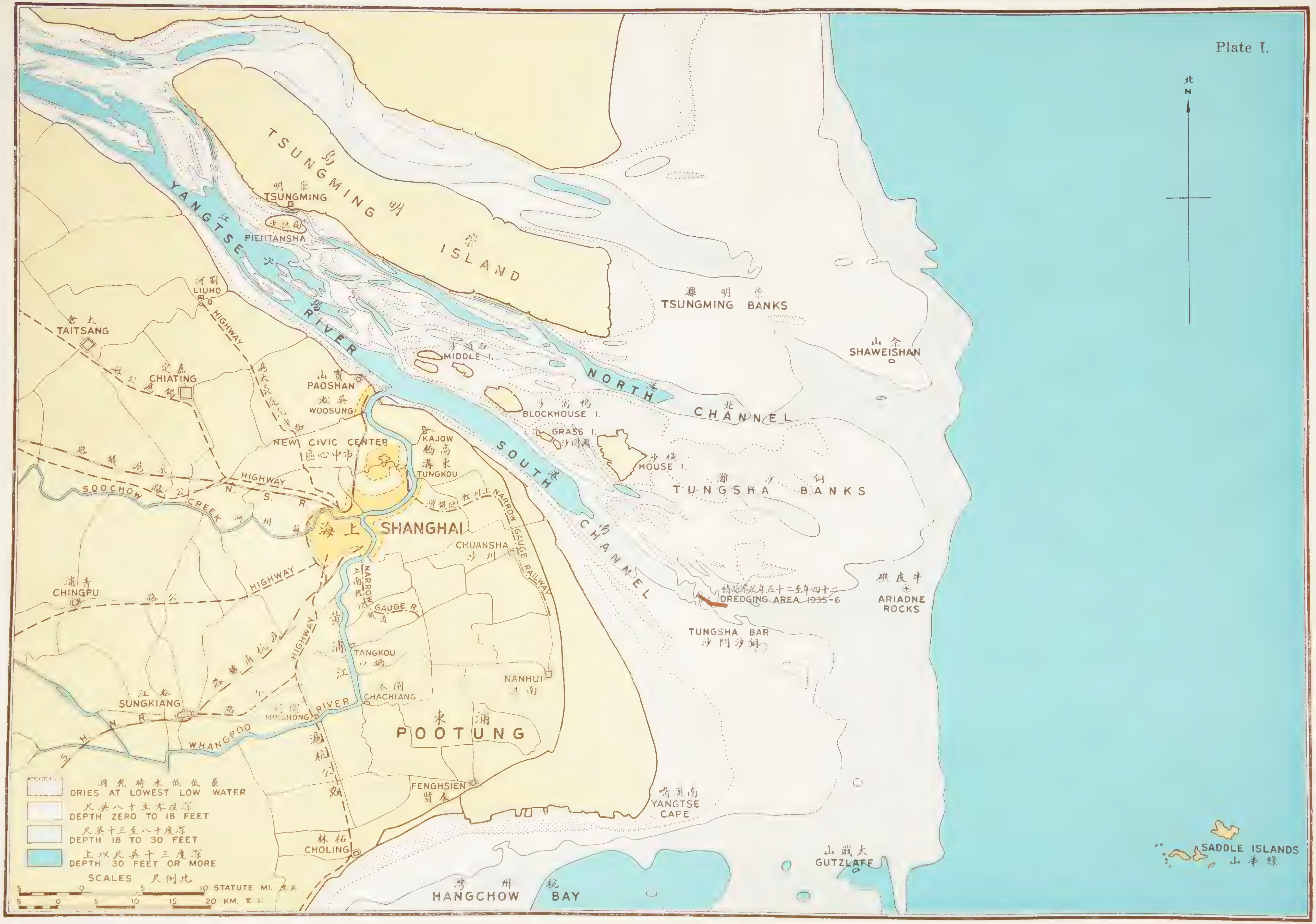


Plate I.—Chart Showing the Approaches to Shanghai.

THE DREDGING PROBLEM

DREDGING EQUIPMENT

It was the object of the project to dredge a channel at least 600 ft. bottom width, with a maximum depth of 9 feet below the crest level, over a length which might amount to 25 sea miles. The minimum depth of water in the channel at extraordinary spring tide was about 17 ft. and the maximum tidal rise above L. L. W. about 16 ft., the mean water level having a rise above L. L. W. of about 8 ft. Tidal currents up to 6 knots, inclined as much as 45° to the axis of the cut, were known to occur, and the water was charged with fine silt up to as much as 2000 parts by weight per million. The bottom was, as far as could be ascertained, a firmish clay-mud with a density of 1.8, a porosity of about 50%, and a shearing resistance of about 300 lbs. per sq. ft. (1½ tonnes per sq. metre). Some patches of fine sand, density about 1.9, with a shearing resistance of about 600 lbs. per sq. ft. (3 tonnes per sq. metre) were later discovered. The underwater slopes were very small, generally less than one per cent. Micro-photographs figures A and B illustrate the appearance of an average sample of Yangtsze mud and sand respectively.

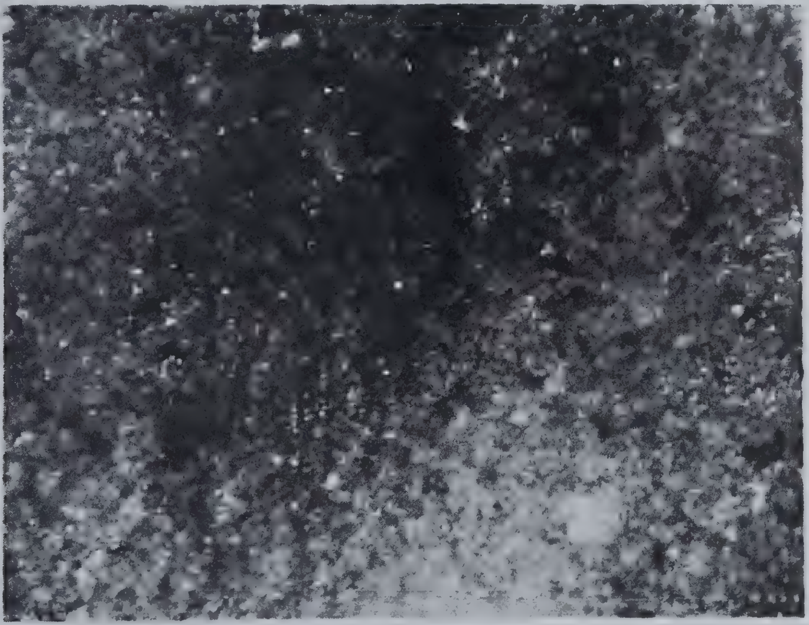


Fig. A.—Micro-photograph of Mud from Yangtsze Bar x 100

The route to be chosen was that of the thalweg, valleyline, or line of greatest depth and allowing for say 50 per cent reaccretion it was considered that two drag dredgers each with an effective annual output of 5,000,000 cubic yards (say 4,000,000 cubic metres) would be adequate.

In view of the small slopes, fine material, strong currents, marine conditions and large silt charge, it was concluded that any attempt to dredge with moored dredgers would be futile so that the trailing type was the only one feasible. The Committee of Consulting Engineers, Shanghai Harbour Investigation, 1921, (Messrs. Black, de Vries, Hiroi, Hornell, Palmer, Perrier and von Heidenstam) had stated that there was reasonable hope of success.

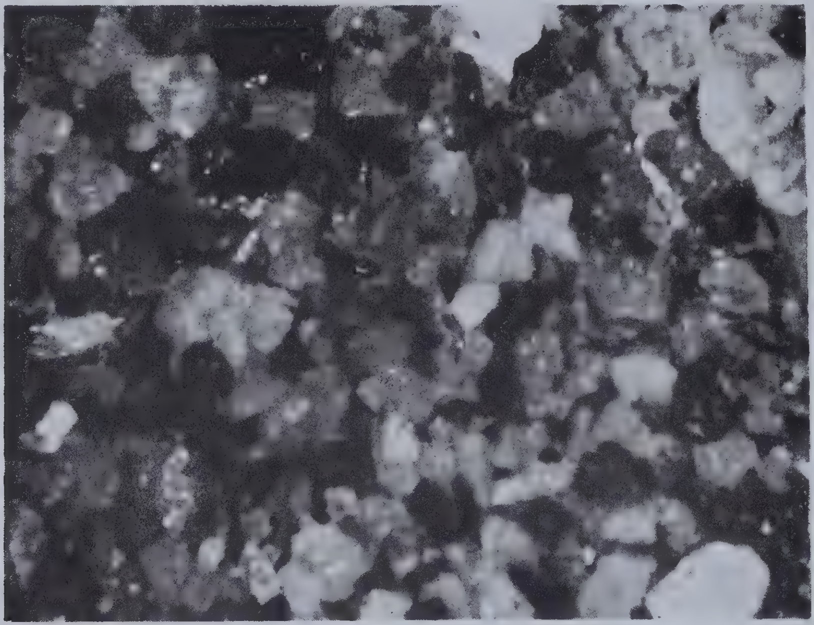


Fig. B.—Micro-photograph of Sand from Yangtsze Bar x 100

A deepish pool suitable for dumping exists within 2 sea miles of the crest of the bar. Night working was not contemplated, at any rate in the first instance, and weather conditions indicated that at least 10 per cent of time might be lost by fog and heavy seas. Allowing further for coaling, repairs and annual overhaul, it was assumed that the working hours per annum might not exceed 2000, implying a rate of 2500 cubic yards (say 2000 cubic metres) dredged, transported and dumped per hour. The transportation and dumping were assumed to occupy half the time; considerations of length, beam and draft, limited the hopper load to about 4000 tons of mixture. Allowing five minutes for approaching the cut and lowering and raising the suction pipe on completion, this implied a dredging rate of 100 cubic yards (77 cubic metres) per minute or 1.67 cubic yards (1.3 cubic metres) per second. Allowing a speed along the cut of 2 knots (3.4 ft. per second or say 1.03 metres per second), the mouth of the drag head needed to be more than 14 sq. ft. (say 1.25 sq. metres). As a certain amount of dilution water would be needed (apart from the high pressure water which enters by jets in the head) and also the head was to be at times oblique to the axis of the cut (on account of the oblique tidal currents), it was decided to specify a width of 9 ft. and a depth of 2 ft., i.e., an area of 18 sq. ft. The study of the mud had shown it to be reducible to a very fluid state with the addition of 50% of water, giving a density of $(0.\dot{6} \times 1.8) + (0.\dot{3} \times 1.0) = 1.53$. Even with 25% of added water—density $(0.80 \times 1.8) + (0.20) = 1.64$—the mixture was quite mobile. Since the added water can enter faster than the mud, the areas provided appeared, and actually later proved, to be adequate.

With such a thick mixture, a fraction of the vacuum is used in supporting the load in the pipe, leaving a smaller amount to overcome friction. Thus if the eye of the pump is at water level (actually in the light draught position it is about **2 ft.** below water level), the lifting head required to raise material with a density of 1.6 is (1.6–1) 45 = 27 ft. or nearly 25 inches of mercury. When the draghead is only 30 ft. below water level, the lifting head is diminished to 18 ft. or 16½ inches of mercury. (If the eye of the pump is 10 ft. below water level, and the draghead 30 ft. below water level only 2 ft. of lifting head is required.) With such a limited margin every effort must be made to reduce the resistance on the suction side. The Builders were therefore required to stream-line the interior of the head, to make the high pressure water nozzles flush and directed in the direction of flow, a single suction pipe 1.1 m diameter was insisted on, and the direct arrangement of the pipe from the head to the eye of a single central low-placed pump was considered essential. In order to avoid variations in the cutting angle and the deflection angle at the back of the head, the pressure water pipe was made into a linkwork which maintains the head in a constant "attitude". A very liberal supply of high pressure water (11 tons per min. at 75 lbs. per sq. in. pressure or 27 tons per minute at 14 lbs. per sq. inch) was allowed.

As a result of all these precautions it proved easy to obtain a mud mixture with a density of well over 1.6 from a depth of about 30 ft., and whole hopper loads with over 1.5 were frequently obtained. Apart from the design, this must be mainly attributed to the smoothness of the mud and the stability of the mixture once it has been churned up. Later, with fine sand about 20 per cent of sand by volume (mixture density 1.18) was about the best result obtained, as against 66-80 per cent with good mud.

The velocities in the suction pipe vary from about 5 ft. per second (say 1½ metres) for thick mud mixture to perhaps twice that value for sandy mixtures.

Still another important aspect of the design is the provision of ample thrust for cutting the bottom with the drag head. Assuming the depth of the cut is 2 ft. and effective width 10 ft. and that the mud ruptures along a plane inclined 1 in 3, the rupture area is 60 sq. ft. which at 300 lbs. per sq. ft. of shearing resistance = 18,000 lbs. or say 8 tons. If this force is exerted at a speed of 3.4 ft. per second, the horse power required is $\frac{18{,}000 \times 3.4}{550} = 111$ H. P.

As it often happens that the adverse current is up to 6 knots (making a total relative water speed of 8 knots) the propelling capacity needs to be ample to cope with the combined ship and drag head resistance. 3000 H. P. at 132 r. p. m. is available from the two propelling engines and the propellers have the following characteristics:—

11′3 3/16″ Dia.
10′9 15/16″ pitch
44.35 sq. ft. area (projected)

The propellers usually run at about 120 r. p. m. when dredging so that the ejection speed is about 21.5 ft. per second. If the relative speed is 10 ft. per second

(6 knots) the impelled speed is 11.5 ft. per second, giving a thrust of about 20 tons, leaving say 12 tons to overcome the ship resistance, which is ample at that speed.

The position of the suction pipe plays an important part in the design of the ship. In the original Frühling design and all the older models the stern of the ship is split and the suction pipe trails below or behind the rudder. This allows much better arrangement of the machinery and hopper and easier handling of the drag head and avoids any danger of the head fouling the well but it makes the vessel very difficult to steer, especially in cross currents, and, if there is any pitching, causes the head alternately to rise in the cut and to bump. The experience in the Argentine is stated to be decidedly in favour of the centre well and this arrangement was adopted, with entirely satisfactory results. It has a further advantage that by means of a strong framework attached to the suction pipe ladder, the latter can be arranged to bear against the side of the well thereby relieving the pipe trunnion of considerable strain.

A very sensitive universal control of the pipe hoisting winch in conjunction with vacuum gauge from the main pump enables the dredging to be carried on steadily and efficiently. One bad feature is that the easing up of the pipe causes the cutting to be least on the hardest places.

DENSITY OF DREDGED MIXTURES.

In drag suction hopper dredging it should obviously be the aim to produce the densest possible mixture which can be pumped. Even if the power required during pumping is in excess of the optimum value for that process per sê the decrease of the cruising and dumping period will generally neutralize any loss of energy due to this cause.

In the writer's paper **"Energy Considerations in Dredging",** published by the Inst. C. E. in 1932 (Selected Eng. Papers No. 125), p. 9, it was indicated that in ordinary pipe line dredging a dilution between 3 and 5 volumes (in relation to the situ volume of the dredged material) gave optimum conditions for a long (1000 ft.) pipe but that in drag suction dredging (p. 15) as little as ½ volume might be sufficient if the mud were smooth.

Practical experience with the dredger "Chien She" on the Yangtze Bar has since shown that for certain conditions the mud might be pumped with almost no added water at all.

The specific gravity of the in sitû material is not of itself the sole criterion to be considered. The grain size is also not the decisive factor, although it is probable that fine grained materials tend to be smoother and therefore will pump more easily than coarse ones. It is obvious that if the proportion of water filled voids ("Porosity") is the same for materials with different sized grains of a given material, the density of mixture will be the same. In practice, great variations of the in sitû density occur with little or no change in the mineral grain density, indicating clearly that the porosity varies largely. If the "pore-coefficient" (ratio of pore space to grain volume) is used the differences are still more remarkable. Thus the mud in the Koeningsberg ship canal at Pillau (E. Prussia), where the "Chien She" had builder's trials, had a density of only 1.25, while on the Yangtze the density was in places over 1.80.

In both cases pumping was possible with about 50% added volume of water, giving densities of 1.17 and 1.53 respectively. Taking the density of the mineral in each case as 2.6 the porosity of the German mud was 0.843 and its pore coefficient 5.4; the Chinese

Fig. C.—MICRO-PHOTOGRAPH OF MUD FROM PILLAU HARBOUR x 100

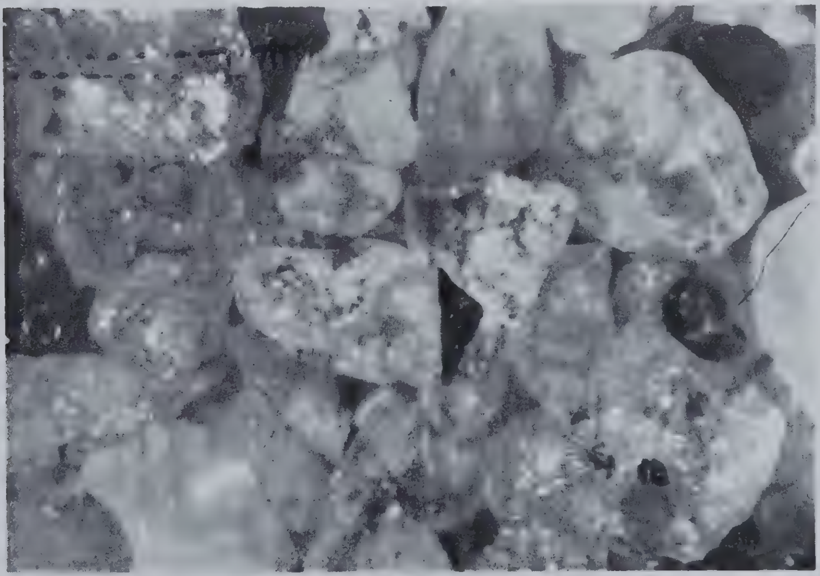


Fig. D.—MICRO-PHOTOGRAPH OF SAND FROM PILLAU HARBOUR x 100

mud had values of 0.50 and 1.0 respectively. The pumped mixtures had values of 0.894 and 8.4 for the German mud and 0.66 and 2.00 for the Chinese mud. Such a difference is only explicable on the basis of a spicular or honeycomb structure in the German material which could remain firm and yet contain a large amount of interior space. Packed dry snow shows a similar anomalously low density due to its spicular structure.* The Chinese mud on the other hand consists of compact or flaky particles which fit well together and only need slight separation to make them free.

All these characteristics have been explained by Prof. Terzaghi in his well known works on Soil Mechanics.

Micro-photographs of the Pillau mud and sand samples are shown in Figs. C. and D. respectively.

DREDGING SAND

There appears to be considerable doubt as to how far the Frühling principle can be applied to the dredging of sand. Experience both in the Yangtze and elsewhere clearly shows that with the ordinary mud head the efficiency falls off greatly when dredging sand. This may be attributed to the following causes:—

(a) Shallower penetration of the cutting edge into the bed on account of increased resistance, allowing much more dilution water to enter the upper part of the opening.

(b) Rapid settlement of the sand in the mixture causing the **average** density of the mixture to be lower than required by minimum dilution.

From experience with the "Leviathan" and other sand pumps, it is clear that in certain circumstances mixtures containing as much as 45 percent by bulk volume of sand (density of mixture say 1.4) may be pumpable and the practical problem is how such a density may be produced and maintained. Many designs have been studied, including disc ploughs, jet intake of suction water, relief valves for suction water, spade pointed and parrot beaked cutting edges, shoe shaped drags with cutting grills, oscillating heads &c. but in many cases these are speculative designs. Some builders hold that the mud form is also the most suitable type for sand dredging especially if a smaller entrance area is provided. Experience in the Yangtze appears to show that reduction of the entrance area by plates which divert the dilution water down on to the entering sand helps. Since the head cannot be buried in the sand as it may be in the mud, because of the extra dilution water wanted and the increased resistance, this appears a logical method. Strengthening the pipe and adding to the propeller thrust is also indicated.

Certain mechanical conditions apply to the cutting of sand which reduce the efficiency of a head designed for mud. The greater resistance of the sand to cutting causes the depth of the cut to be less, exposing the upper part of the opening to the relatively free inflow of the water. The velocity of inflow of the water is determined by the residue of the vacuum which remains after deducting:— (a) The head required to support the excess of the mixture density above unity, and (b) the friction in the pipe. With thin mixtures (a) is small (e.g., if the density is 1.20 and the lift is 40 ft. the head required is 8 ft.; if the density is only 1.10 the head required is only 4 ft.) As to (b) the friction on the pipe is small except for high densities or very high velocities. If the velocity is 20 ft. per second the resistance per sq. ft. is about 2 lbs. or about 2000 lbs.

---

*(Loose dry snow has a density of 0.0833. Since ice has a density of 0.926 and the spaces in the snow are filled with air of practically no weight, the porosity is .91 and the pore coefficient 10! By pressure snow may be consolidated but unless the pressure is sufficient to cause local melting and freezing solid, the porosity remains quite large.)

for the whole suction pipe or 160 lbs. per sq. ft. of section, or say 1 lb. per square inch, 1/15 atmosphere or say 2 ft. head. (For clean water)

Hence if the vacuum at the eye of the pump is 26 ft. of water (say 24 inches of mercury), there may easily remain 9 ft. of vacuum at the mouth which will produce a water influx velocity of $\sqrt{64 \times 9} = 24$ ft. per second. If the water area is half the opening and the sand is being cut at a speed over the bottom of 3 ft. per second, the ratio of water to sand is as $\frac{24}{3}$ or 8 times as much giving a mixture with a density of about

$$\frac{(1 \times 2.0) + (8 \times 1)}{9} = \frac{10}{9} = 1.11$$

If the water intake area can be **halved** (= ¼ the whole area) by a flap, the ratio is as 12/3 or only 4 times giving a mixture density of

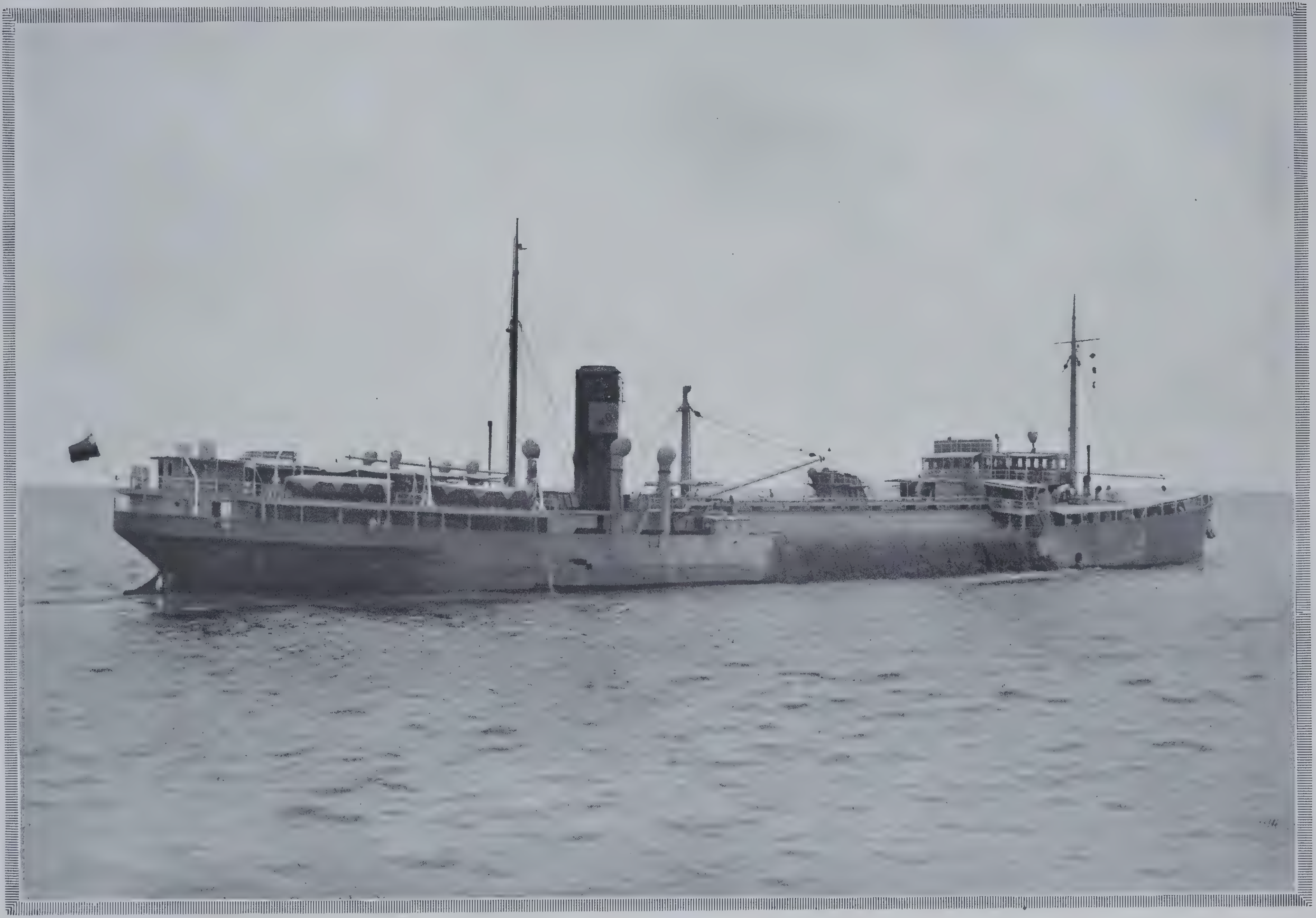
$$\frac{(1 \times 2.0) + (4 \times 1.0)}{5} = \frac{6}{5} = 1.20$$

If the water intake area were **quartered** (= ⅛ the whole area), the ratio would be as 6/3 or 2 times, giving a mixture density of

$$\frac{(1 \times 2.0) + (2 \times 1.0)}{3} = \frac{4}{3} = 1.33$$

This is probably the limit as the head required to lift the mixture now begins to grow appreciably.

This cutting down of the water area will not increase the quantity dredged which depends wholly on the depth of the cut, but it will increase the density of the mixture, so prolonging the dredging time required to fill the hopper and reducing the proportion of dumping time.



The Dredger "CHIEN SHE" at Yangtsze Bar.

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DESCRIPTION OF THE DREDGER "CHIEN SHE"

On the 9th February 1935 there sailed from Danzig the new Twin screw steam Drag Suction Dredger "Chien She" built to the order of the Whangpoo Conservancy Board, Shanghai, by F. Schichau, G. m. b. H. at their Danzig yard; the machinery and dredging equipment having been constructed at their works in Elbing, Germany.

The voyage to Shanghai, conducted under the most economical steaming conditions to obviate re-bunkering was accomplished in 64 days and after completing a very extensive series of dredging output trials, which were successfully carried out with an ample margin, she was handed over to her owners on the 4th July 1935.

Since the "Chien She" was commissioned for service on the Yangtsze Bar the guarantee period has elapsed and a description of the vessel and analysis of the actual dredging work accomplished during that period is of considerable interest.

The principal dimensions and other important particulars of the "Chien She" are given in Table I as follows:—

Table I.—Principal characteristics of the Dredger "Chien She"

Particulars	English	Metric
Length overall	373′-0″	113.690 m.
Length B. P.	360′-0″	109.726 ,,
Breadth, moulded	60′-0″	18.288 ,,
Depth, moulded	26′-6″	8.077 ,,
Gross Tonnage	4699 tons	4,774 tonnes
Net Tonnage	1858 ,,	1,887 ,,
Load draught, normal	18′-0″	5.486 m.
Deadweight tons	4500	4,572 tonnes
Hopper capacity, cubic yards, to top of coaming	4200	3,210 cub. m.
Hopper capacity, cubic yards, to deck level	3700	2,828 ,, ,,
Maximum dredging depth	45′-0″	13.715 m.
Dredging output of solid in situ mud from the Yangtsze Bar of density 1.8 metric tons per cubic metre, dredged, transported in hoppers, deposited by hopper doors two sea miles distant from dredging base in a total of 10 working hours ...	25,000 cub. yards	19,110 cubic metres

The vessel has been built in accordance with the requirements of Lloyd's Register of Shipping under Special Survey, the classifications ✠100 A. I. Hopper Dredger having been assignd by that authority. The regulations of the Board of trade have also been fully complied with.

GENERAL ARRANGEMENT

The photograph of the Dredger "Chien She" reproduced in the frontispiece, illustrates the vessel in service condition which to all outward appearance resembles that of a modern cargo steamer rather than a typical drag suction dredger.

The vessel has a raked stem of rounded plate form, and elliptical stern, a single funnel and two tall masts. The rudder is of the double plate type of stream-lined design and electrically welded construction as shown in Fig. 32; the steel castings having been supplied by the Builders Steel Works at Elbing, who also manufactured the stern frame and shaft brackets. The hull plating is bossed in way of the two lines of shafting and extends aft to the propellers.

The general arrangement of the vessel may be seen from the elevation and deck plans given on Plates Nos. II, and III and Midship section plan Plate IV.

Watertight sub-division is effected by six transverse bulkheads all of which extend to the level of the main deck, with the exception of the bulkheads at the fore and after ends of the hopper spaces, which are carried up to the upper deck. The vessel is further subdivided longitudinally by a centre well amidships in which the suction pipe and dredging ladder is situated. Forward of the well is an additional watertight compartment through which the suction pipe passes to the Dredging pump. This compartment is provided in case of damage to the well during dredging and also contains the hydraulically operated main sea suction, shut off valve.

On either side of the centre well is arranged the spoil hoppers constructed with sloping sides which form large buoyancy spaces at the ships' side and centre well sides respectively. The outer spaces have extra deep floors plated over and arranged as feed water tanks built with recesses in way of the sea suction valves to hoppers; the tank top plating and connection to ship and hopper sides being of welded construction. The spaces at the centre well side are utilized for the installation of the main suction pipes and valves from the hoppers.

The peak tanks have a large capacity arranged for trimming purposes. A summary of the capacities of the various fuel bunkers and tanks for fresh water and water ballast is given in Table II.

Table II—Tank Capacities.

	Tons
Bunkers :—	
Cross bunkers oil fuel, 6740 cub. ft. Coal, 6460	145
Starboard bunker oil ,, 12050 ,, ,, ,, 10300	228
Port bunker ,, ,, 12350 ,, ,, ,, 10510	232
Settling tanks ,, ,, 1000	
Total Coal Capacity	605
Fresh Water :—	
Feed water tanks, port	127
Feed water tanks, starboard	127
Drinking water tanks	18
Total fresh water	272
Water Ballast :—	
After peak	154
Fore peak	156
Total water ballast	310

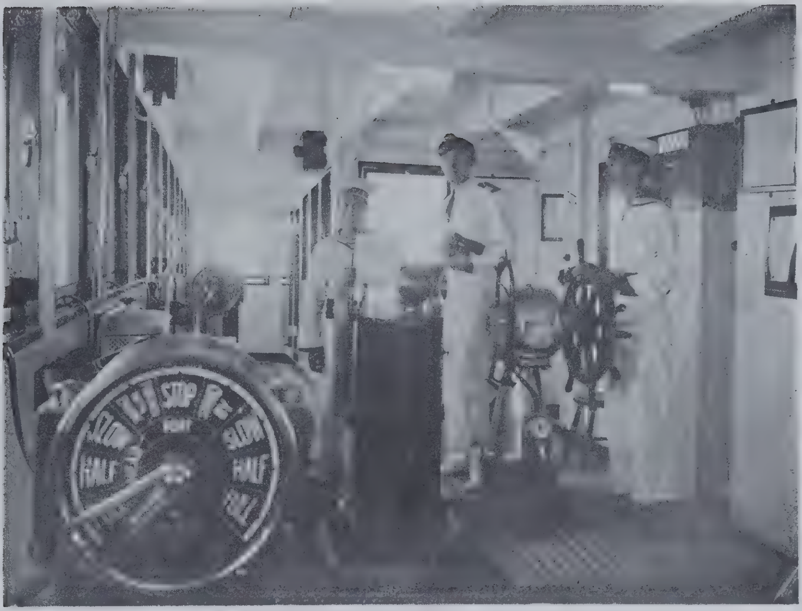

Fig. 1.—VIEW OF THE NAVIGATING BRIDGE.

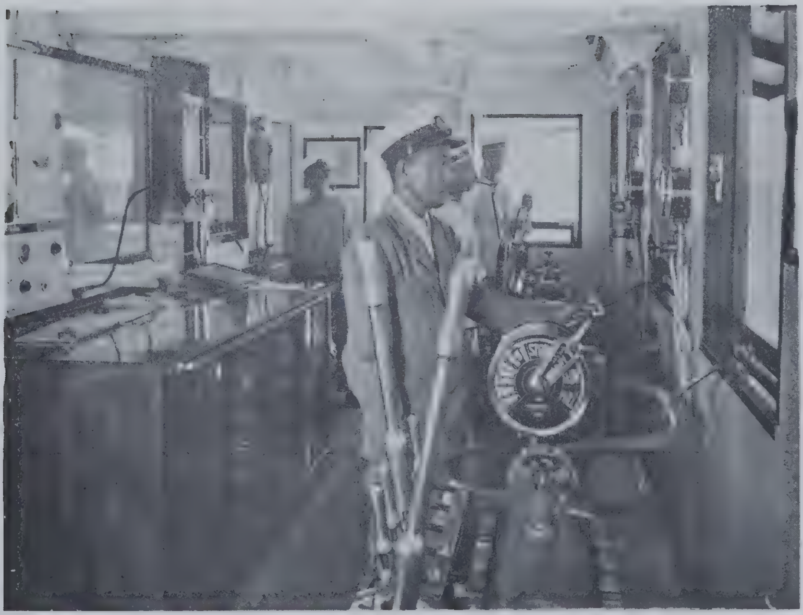

Fig. 2.—VIEW OF THE OPERATING CONTROL ROOM.

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A large cargo hold is arranged forward for the storage of wire ropes, stores, and spare dredging equipment; aft of which is the Pumping engine room, the Hopper spaces, Boiler room and Propelling engine room respectively, whilst an insulated and refrigerated chamber having a storage space of 600 cubic feet in three compartments is situated in the tween deck aft.

The Navigating bridge which extends from side to side of the vessel is enclosed in a steel casing lined with triple plywood and having large opening windows on all sides, The Bridge deck is of teakwood and arranged with a double set of engine room telegraphs, a telemotor steering control, a Kelvin steering compass, controls for a powerful searchlight fitted on the Flying bridge, an electric navigational light and dredging signal indicator, and a Siemen's electric helm indicator. The arrangement of the Bridge is seen from Fig. 1.

Aft of the bridge and communicating with it on the same deck is the Dredging control room and chart house in which is installed the Drag head operating wheel, pressure and vacuum gauges, and the hydraulic control levers for manoeuvering all the suction and discharge valves in connection with the dredging equipment throughout the vessel. There is also installed, the Pump room telegraph, an electric indicator for the sluice valves, the loud speaking telephones, a "Hughes" Echo sounder, and a "Dobbie—McInnes" draught and displacement indicator. A view of the Control room is shown in Fig. 2.

The whole interior of the Navigating Bridge and operating room is smooth finished in white enamel and presents a fine appearance with all the navigating and dredging equipment neatly and conveniently arranged.

ACCOMMODATION FOR OFFICERS AND CREW.

The accommodation for the Captain and Dredging Master, First Officer, and Chief Engineer, is arranged below the Bridge deck together with the Wireless room and Office. On the main Deck aft six additional Cabins are provided for the deck and engine room Officers. The cabins are unusually large, well ventilated and comfortably fitted out for the tropical weather conditions under which the dredger has to work during the summer months. The steel decks forward and aft in way of all accommodation are sheathed with teakwood planking.

Cabins for the Chinese Senior ratings, including: Dredging laodahs, Wireless operator, Engine room artificers and Armed guards are arranged forward, at the port and starboard sides of the pump room casing. In the 'tween deck forward light and airy accommodation is provided in four separate spaces for sailors, oilers, firemen, cooks and boys, fitted up with steel frame berths, lockers, and tables. The forecastle deck is of teakwood, and the 'tween decks in way of crews' space of oregon pine.

Well fitted bathrooms and toilet facilities are arranged in conjunction with the Officers and Senior ratings accommodation, whilst spacious toilet room, lavatories, and wash houses, are provided for the use of the crew.

On the poop deck aft is situated a suite of three staterooms, with bathroom and toilet adjoining for accommodation of the Board's Officials and Dredging Engineer during inspection visits to the dredger.

The full complement of the vessel is given in Table III as follows:—

Table III.—Complement of Officers and Crew.

	Persons
Captain and Dredging Master, and Deck Officers	4
Chief Engineer, and Engineer Officers	5
Chinese Senior deck ratings and Medical Officer	15
Chinese Senior engine room ratings	13
Sailors 18, Oilers 7, Firemen 20	45
Steward 1, Cook 6, Boys 7	14
Other non -ratings	10
Total	106

DECK MACHINERY.

All the deck machinery of the "Chien She" has been constructed at the Builder's Works at Elbing and is entirely of steam operated design.

The windlass is of the patent direct-grip, horizontal type, of specially massive construction for daily duty under service conditions and is mounted on the main deck forward. The cable holders are suitable for 2-1/8″ stud link chain cable, each having four snugs; warping ends are also fitted for mooring purposes. The equipment includes a pair of patent self holding and automatic releasing bow stoppers. Hand gear is also fitted to the windlass. The anchors are of the stockless type.

Two double cylinder horizontal steam winches are installed; one forward on top of pump room casing for serving the cargo hold 5 ton derrick, the other situated on top of the fidley casing working in connection with the 8 ton derrick for handling the suction draghead.

The steam steering gear, which has also been constructed by the Builders, is of the horizontal double cylinder, vertical type operating a cast steel rudder quadrant fitted direct to the rudder stock. The gear is controlled from the navigation position by telemotor equipment.

There are also two steam warping winches and two coaling winches of the horizontal double cylinder, single drum type installed on the after main deck, one of the warping winches being arranged with a gypsy for handling the stern anchor.

A powerful double cylinder steam Hoisting winch Fig. 3. is fitted on the hopper deck abaft the navigating bridge by means of which the outboard suction pipe and ladder is raised and lowered in the centre well. The winch has double drums of large diameter with machine cut grooves for the steel wire cables the ends of which are connected to buffer springs for taking up shocks which might occur during dredging, in order to prevent excessive stresses on the lifting cables. The hoisting drums are operated by a steel worm drive from the steam engine, gearing into a solid bronze machine cut worm secured to the drum shaft. The engine is controlled from the operating room on the bridge deck by means of a flexible shaft and gearing.

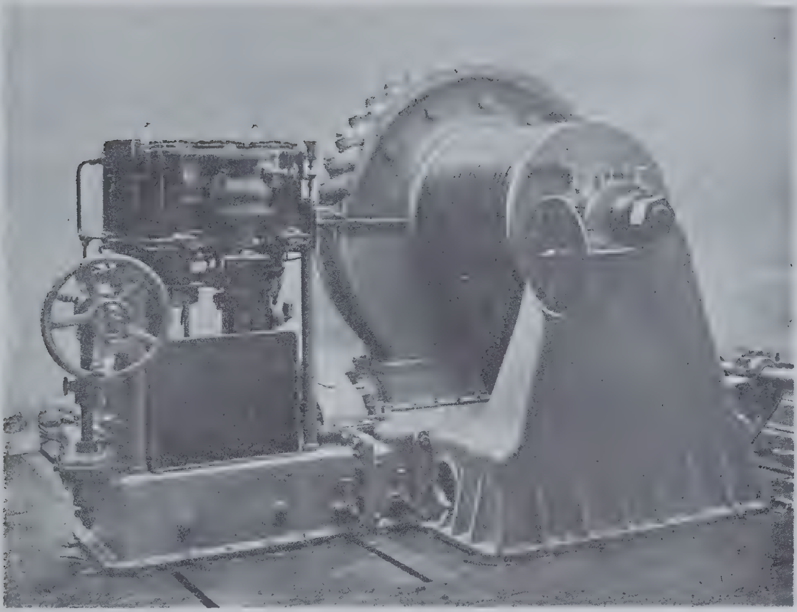

Fig. 3.—Ladder Hoisting Winch and Engine

A brass dial graduated in feet, is arranged one at the draghead control column and the hoisting drums respectively, for indicating the depth of the draghead below water level.

EMERGENCY ARRANGEMENTS.

Reference to the sub-division arrangements has already been made, and it may now be mentioned that door openings are arranged in the watertight bulkheads communicating with:–the outer and inner buoyancy spaces, the pump room, boiler room, and engine room, each fitted with a quick-closing watertight door which is also arranged for hand-operations from the main deck.

The lifeboat equipment comprises two 26 foot standard boats of oregon pine and one 24 foot working motor dinghy equipped with a 2 D. M./18.5 B. H. P. "National" Engine.

The boats are carried in patent davits of the "Welin" type. An adequate supply of life rafts and life buoys is provided.

The Wireless-telegraphy installation which has been supplied by the Marconi International Marine Communication Co., Ltd., of London includes a X. M. C./2 A. type, completely self contained wireless telephone and telegraph transmitter designed for point to point working. The set operates on a single wave length chosen to suit the particular service at any spot wave between 150 and 450 metres. In cases where it might be required to communicate by telephony or telegraph using the normal 600 metre wave a unit for this purpose is located at the back of the transmitter and can be utilized by means of a rapid change over switch.

Under service conditions the ship's wirelesss set operates on a fixed wave length in communication with an independent shore station through which the movements and daily records of the dredger's working is reported to the Board' Head Office.

NAVIGATING EQUIPMENT.

The outfit of magnetic compasses has been supplied by Messrs. Kelvin, Bottomley. & Baird Ltd. of Gasgow and comprises two of this firms "Kelvite" pattern liquid card instruments supported on a solid teak pillar with patent suspension.

As previously mentioned a British Admiralty silent magneto-striction, echo sounder with recorder, supplied by Henry Hughes & Son, Ltd is installed for taking soundings over the dredging area.

Messrs. Siemens have supplied the installation of loud-speaking telephones communicating between the navigating bridge and the steering position on the poop deck, and between the propelling and pumping engine rooms, all inter-connected. The same firm has also installed an electric indicator for the ship's navigating lights and dredging signals.

A "Teledep" draught and displacement instrument supplied by Messrs. Dobbie McInnes & Co., Glasgow is installed in the operating room for indicating the conditions of loading in the hoppers during dredging.

DREDGING ARRANGEMENTS AND EQUIPMENT.

The main hoppers, which are situated on either side of the centre well, amidships, have an aggregate capacity of 2850 cubic metres (3700 cubic yards) to deck level. The hoppers are constructed with sloping sides, with cross girders at bottom which divides each hopper space into ten compartments, open at the bottom, and closed by means of a double row of steel cased doors lined with oak wood. The doors Fig. 4. are supported

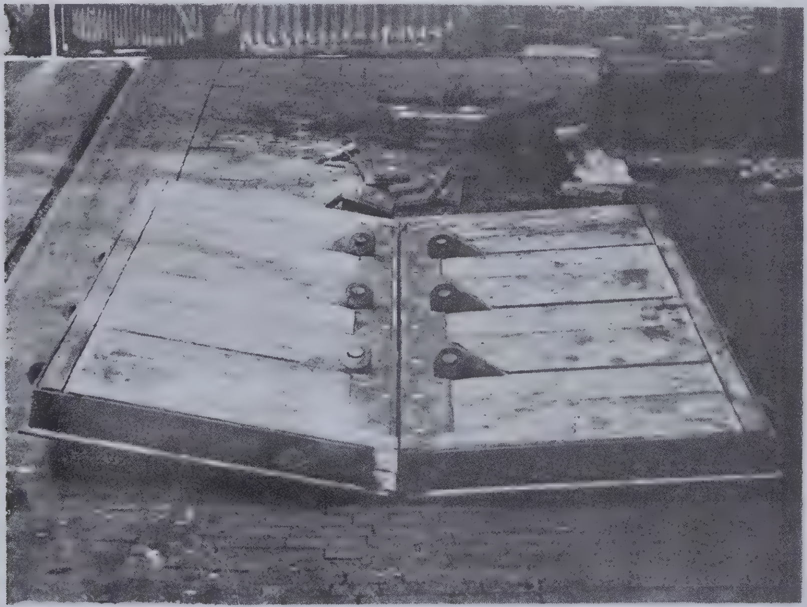

Fig. 4.—A pair of the Hopper Bottom Doors.

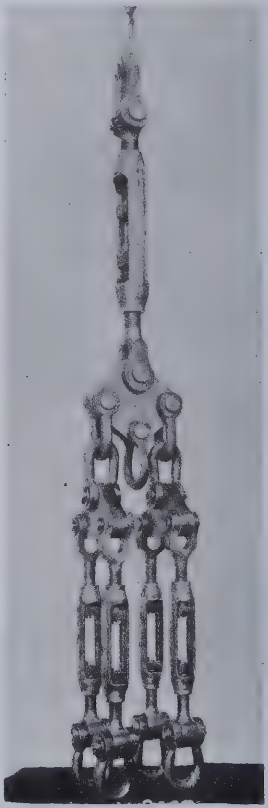

Fig. 5.—Turnbuckles and Shackles for Hopper Door Gear.

on strong forged steel hinges fitted with manganese steel pins and bushes and when closed press against oak wood frames lined with leather jointing. Each door is raised by two steel wire strops fitted with stretching screws and connected to equalising gear in order to ensure equal loads on all the supports.

Each pair of door wires is further connected to a second equalising gear Fig. 5. to which is attached the main chains leading to a sliding motion girder running along continuous gangways on the hopper tops. The sliding girder for opening and closing the hopper doors is actuated by means of a hydraulic ram situated one on either side at the after end of the hopper gangways. The rams are arranged to work at a pressure of 600 lbs. per sq. inch.

This arrangement makes it possible to operate each pair of doors separately or any number of them together.

During loading of the hoppers the main door chains are supported by means of a forged steel cottar secured to a cast steel stool on the hopper gangway which also forms the sliding faces for the hydraulic motion bar.

Perhaps the most interesting part of the whole dredging gear is the dredging head, or draghead, and the outboard suction pipe for conveyance of the dredged material to the pump. The utmost care has been taken in the design of this equipment in order to reduce to a minimum friction losses at the draghead entrance and in the suction pipe, and with this object in view the various parts and sections have been made of stream-line form.

The suction pipe is arranged in a strong girder frame of steel plate and angle construction secured to massive steel castings at either end; the lower casting being arranged with bearings and shaft to take the draghead, the upper casting having side journals of large diameter which are supported in heavy bearings secured to the centre well sides. Attached to the upper casting is a cast steel machined sliding joint which rotates in a steel casting secured to the forward end of the centre well plating, the joint being made watertight where the sleeve passes through the hull, and connects to the main suction pipe to the Dredging pump. The details of this connection are clearly shown in Figs. 6 and 7.

The general arrangement of the outboard equipment is shown on Plate V. together with the pipe line and hydraulic sluice valves in connection with the Dredging pump.

It should be noted that the dredging pump has been kept as low as possible in order to reduce the suction lift.

The lower part of the outboard suction is fitted with an interchangeable cast steel suction draghead of massive design and construction, fitted at the entrance with manganese steel cutting blades and having vertical grid plates for the purpose of excluding large objects and wreckage from entering the pump. Three different sizes of dragheads have been supplied measuring six, eight and ten feet respectively on the cutting edge, one of which is illustrated in the two views Figs. 8 and 9. The inner surfaces are streamlined throughout and the head is cast with a water jacket fitted with pressure water jet openings facing in the direction of flow of the spoil, which can be used to provide water lubrication on the inner skin of the casting when dredging stiff materials.

Another interesting and important feature of the draghead is the mechanism for maintaining a constant angle at the cutting edge of head irrespective of dredging depth, tidal variation or loaded conditions of the dredger.

This arrangement which is shown in Fig. 9 and Plate V. consists of two cast steel, lever shaped, arms mounted on top of the draghead, connected at the upper end to a branch piece, the ends of which form a journal rotating in the lever ends. These side arms are cast hollow and serve to convey the pressure water service to the water jacket in the draghead. The branch piece joins a "Mannesman" solid drawn steel pressure water pipe which in turn is connected to a second cast steel branch piece mounted on bearings secured to the forward end of the centre well. By means of this mechanism, the cutting angle of the draghead, after having been set to suit the conditions of dredging, remains fixed for any position of the head, the variation of angle being taken up by a sliding sleeve secured to the upper part of the draghead. A general view of the suction ladder with draghead attached is shown in Fig. 10.

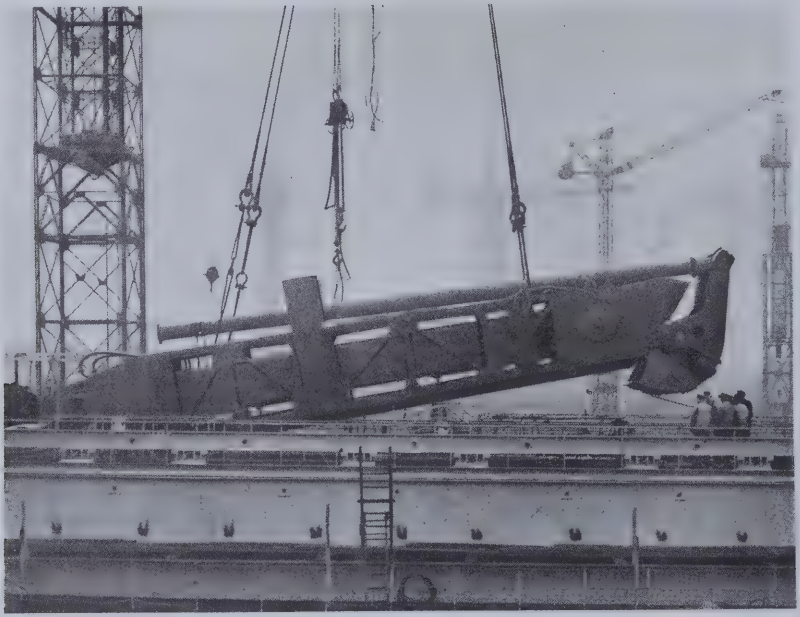

Fig. 10.—General view of the Suction Ladder and Draghead.

The suction ladder is housed within the centre well and has heavy wood faced fenders on both sides which bear on doubling plates on the well sides during dredging. The lower end of the suction pipe and ladder is suspended from the hoisting platform by steel wire ropes, raised and lowered by means of the hoisting winch already described. A view of the centre well and suction ladder is shown in Fig. 11. and Fig. 12. shows the draghead in the top position.

The Main dredging pump is of the centrifugal type, built of cast steel sections bolted together and lined internally with manganese-steel wearing plates. The impeller is of the semi-shrouded type 8′–6″ diameter over tips, having four mild steel blades 20" in width riveted to vanes cast on to the impeller disc. The impeller shaft is 13¾" diameter at the bearing and connects through a "Michell" type thrust block to the main

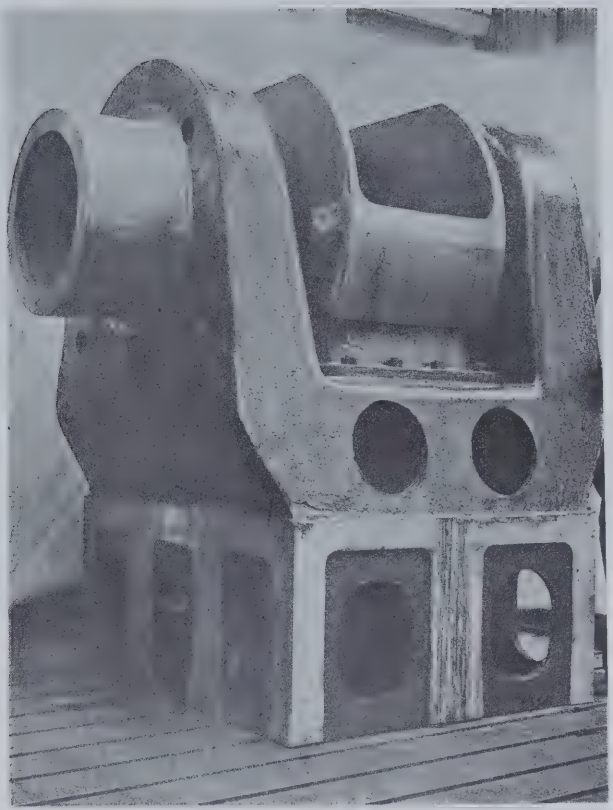

Fig. 6.—Sliding Joint and Trunnions of Suction Ladder.

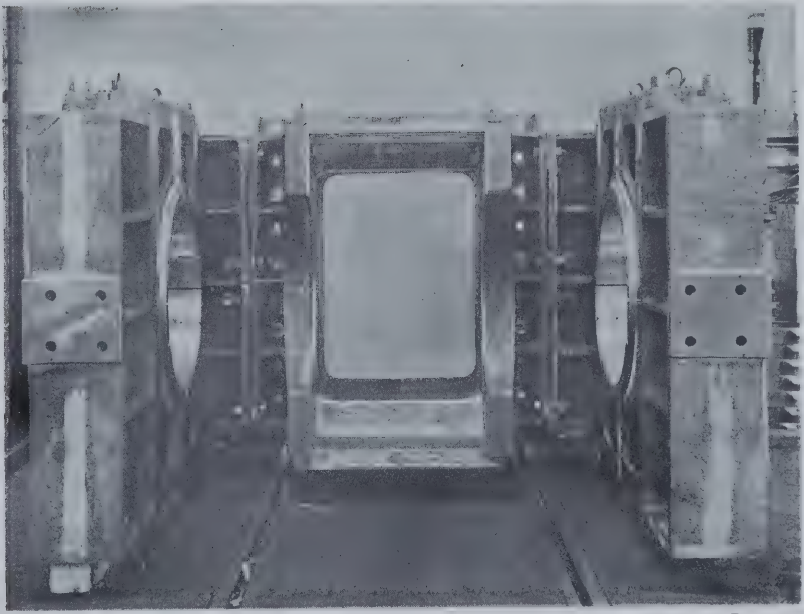

Fig. 7.—Side Bearings and Opening for Suction Sliding Joint.

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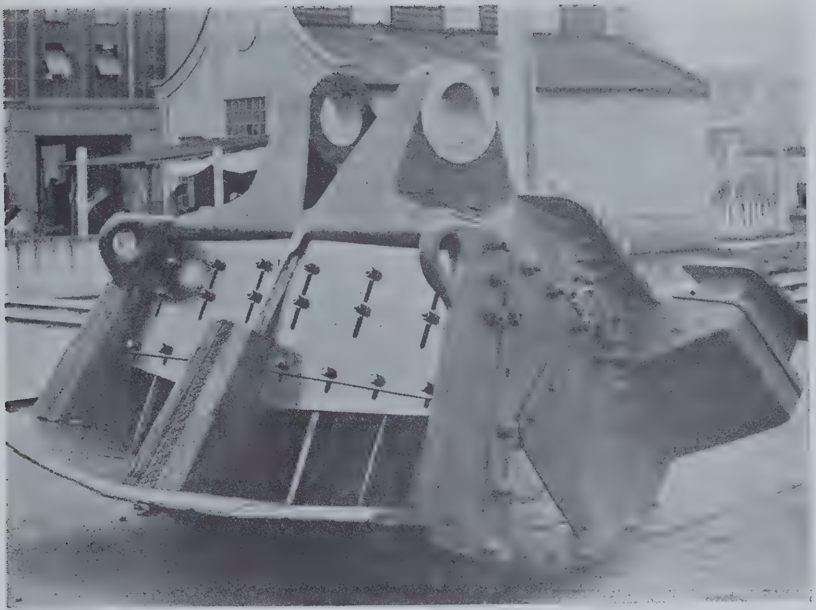

Fig. 8.—FRONT VIEW OF DRAGHEAD SHOWING CUTTING EDGE AND GRID PLATES.

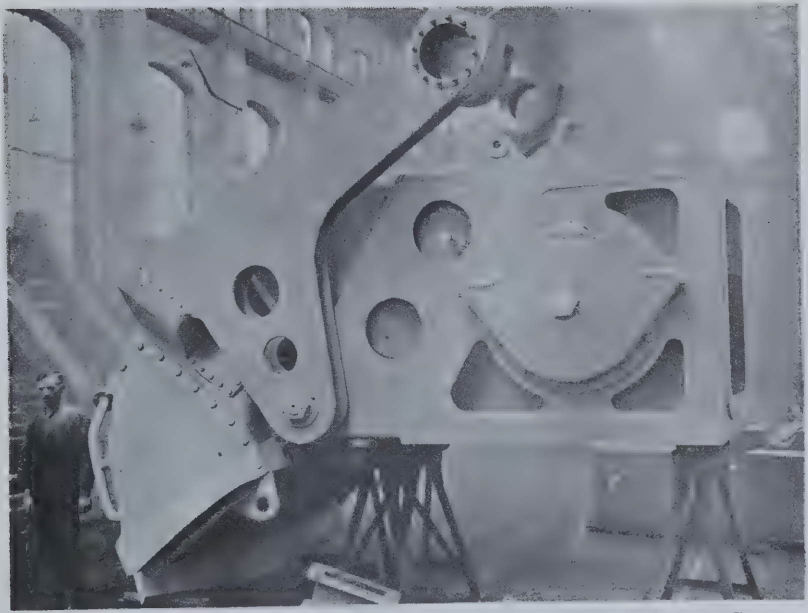

Fig. 9.—SIDE VIEW OF DRAGHEAD SHOWING SIDE LEVERS FOR ANGLE CONTROL.

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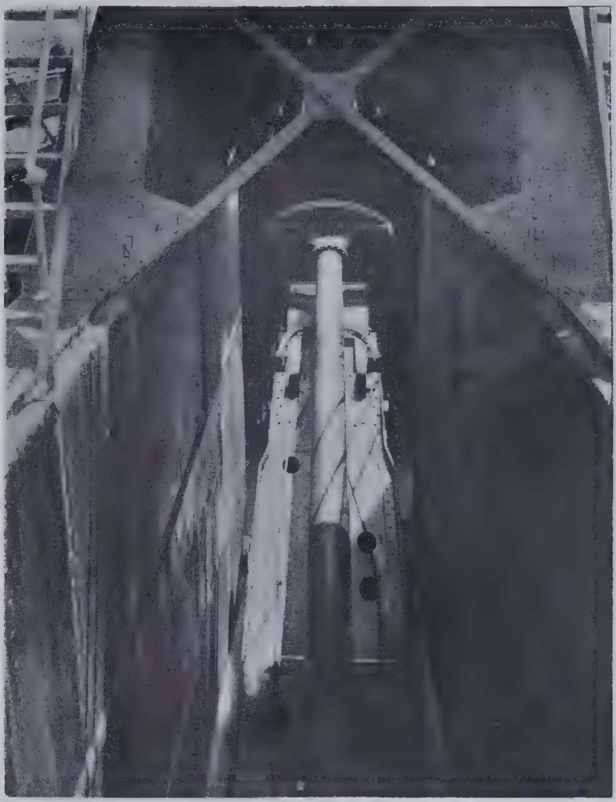

Fig. 11.—View showing Centre Well and Suction Ladder.

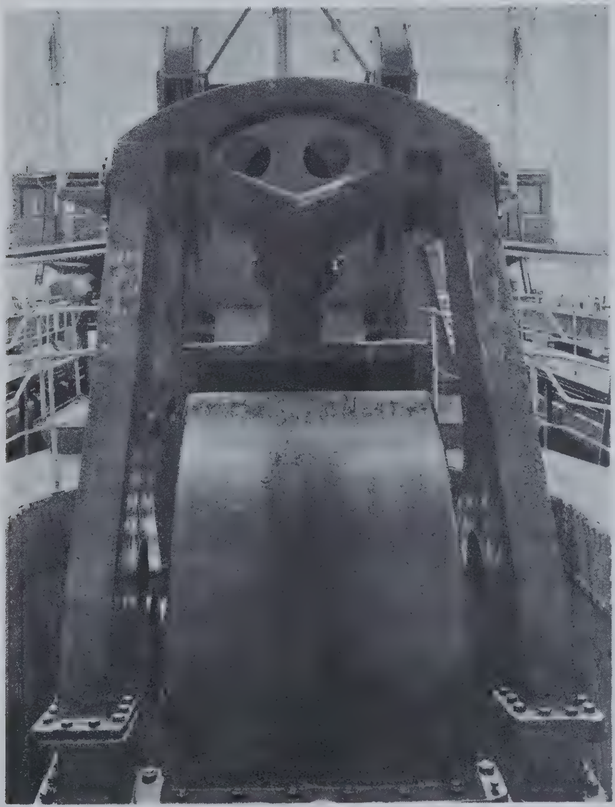

Fig. 12.—Suction Ladder and Draghead in top position.

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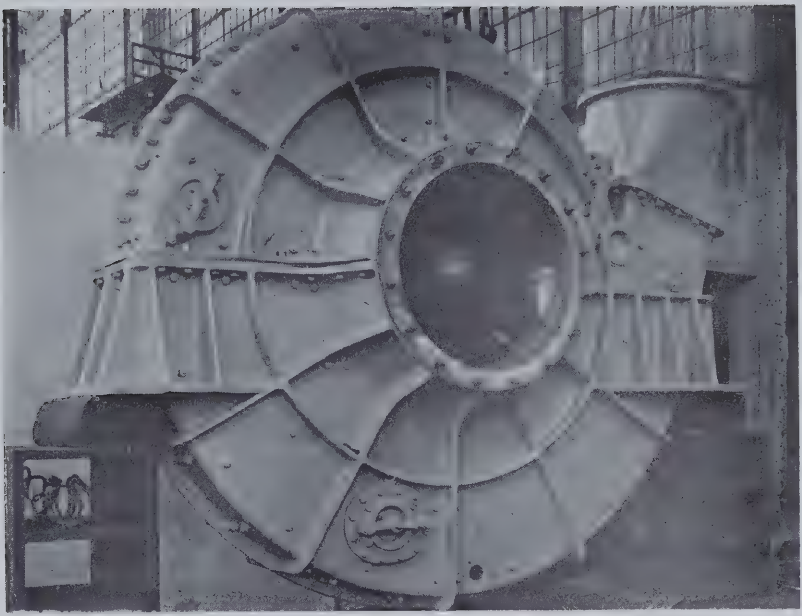

Fig. 13.—Main Dredging Pump.

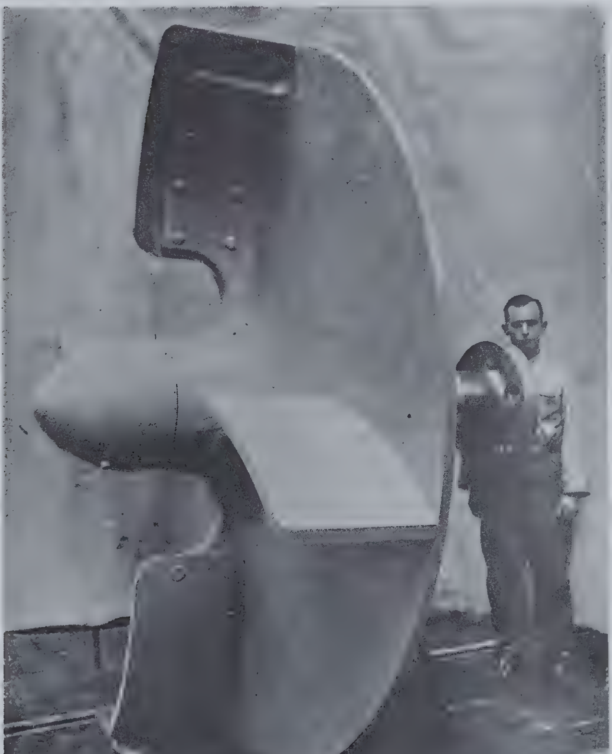

Fig. 14.—Dredging Pump Impeller.

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pumping engine. The impeller shaft bearing is fitted with a patent sand excluding device to which a supply of clean water under pressure is kept in circulation.

The pump which may be seen in Fig. 13. and impeller Fig. 14. has a water pumping rate of 18000 tons per hour at a speed of 120 revolutions per minute when delivering through the distributers at the hopper tops, and when dredging thick mud, having an in-sitû density of 1.8, the pump can fill the hoppers with a load of 4000 tons in less than 20 minutes.

The arrangement of suction and delivery piping and valves makes it possible to draw the dredged up material from the draghead and deliver it direct to the hoppers, or if required, it may be pumped overboard for reclamation purposes. It also permits of the hoppers being pumped out and discharged overboard.

Each particular method of pumping is controlled by manoeuvering appropriate sluice valves in the suction and discharge pipes, all of which are hydraulically operated by control levers, arranged in the operating room on the Bridge deck. The main discharge pipe from the pump is divided at the main deck level into two separate discharge pipes leading to the port and starboard hoppers respectively, each having five outlets or distributors spaced at intervals along the length of the hopper and fitted with a hydraulically operated sluice valve for control of the loading and to ensure an equal distribution of the load in the hoppers.

Particulars of the various suction and discharge connections are given on the following Table No. IV.

Table IV.—Particulars of Suction and Discharge Connections.

Description	Number	Dimensions	
		Millimetre	Inches
Maximum opening at entrance to 8 ft. draghead	—	2400 x 900	96″ x 35½″
Suction opening in draghead crown	1	1100 x 900	43⅜″ x 35½″
Section of Outboard suction pipe	1	1200 x 800	47¼″ x 31½″
		Diameter	
Main dredging pump suction	1	1100	43⅜″
Pump suction branches from hoppers	2	700	27½″
Pump suction from sea	2	300	11¾″
Mixing water sea valves	10	560	22″
Main dredging pump discharge	1	1000	39⅜″
Overboard discharge pipes	2	1000	39⅜″
Discharge pipes to hoppers	2	700	27½″
Discharge outlets to hoppers	10	450 x 586	17¾″ x 23″
Pressure water pump sea suction	1	450	17¾″
Pressure water pump discharge	1	400	15¾″
Pressure water connection to doors	1	100	4″
Clear openings in bottom for dumping	10	2060 x 2230	81″ x 88″

Independent sea inlets each fitted with hydraulically operated sluice valves are arranged, five on each side of the vessel, with short inlet pipes leading to the lower compartments of the hoppers. These inlets are placed directly opposite the suction openings from the hoppers and are used for diluting the hopper mixture when the load is being pumped overboard, from the hoppers.

A double stage centrifugal pump having both chambers working in series constructed by the Builders, is installed in the Pumping engine room for the supply of high pressure water to the draghead water jets and also to the bottom door frames for cleaning the joints after the spoil has been dumped. This unit is illustrated in Fig. 15.

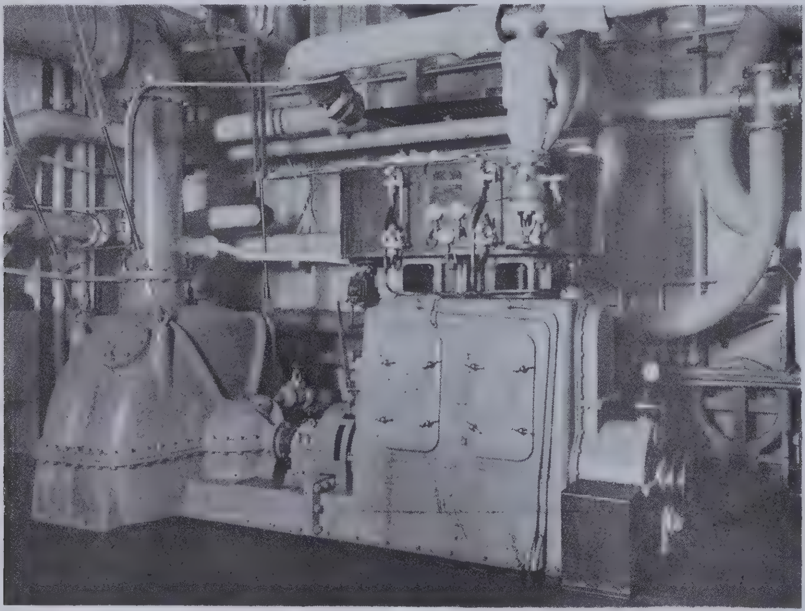

Fig. 15.—FLUSHING PUMP AND ENGINE.

The pump has a capacity of 2500 gallons per minute against a head of 150 feet or 6000 gallons at 30 feet head, and is driven direct by a set of vertical compound, enclosed type, engines developing 290 I. H. P. at 325 revs. per minute.

Two steam driven hydraulic pumps are also installed for providing the necessary high pressure water supply to the various hydraulic rams and sluice valves in connection with dredging equipment. The pumps are of the vertical duplex, long stroke type, arranged to work at a water pressure of 750 lbs. per square inch, the door rams being operated at about 600 lbs. per square inch and the individual sluice valves at a reduced pressure of 250 to 300 lbs. per square inch. The pumps are fitted with regulator controls on the steam and water ends of the system.

PUMPING MACHINERY.

The main dredging pump is driven direct by a single vertical triple expansion, marine type steam engine having cylinders 500 m/m.—820 m/m.—1350 m/m. diameter respectively by 950 m/m. stroke ($19\frac{11}{16}$″-$32\frac{1}{4}$″-$51\frac{3}{16}$″ × $37\frac{3}{8}$″) capable of developing 2400 Indicated Horse Power at a normal speed of 150 revs. per minute.

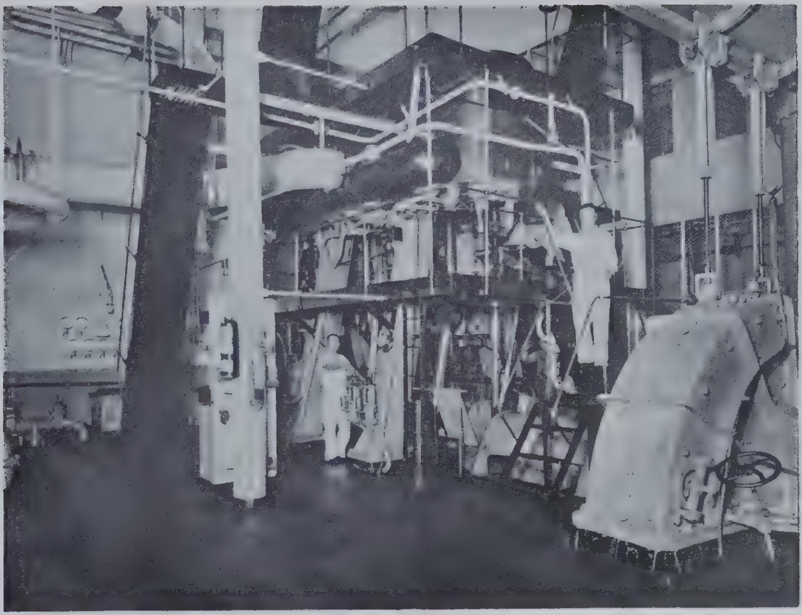

Fig. 16.—General view of the Pumping Engine Room.

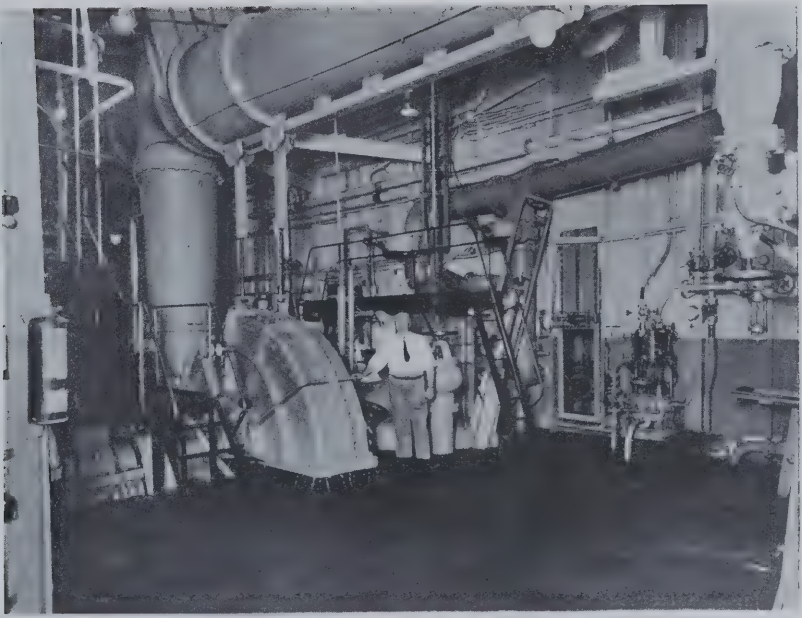

Fig. 17.—General view of the Pumping Engine Room.

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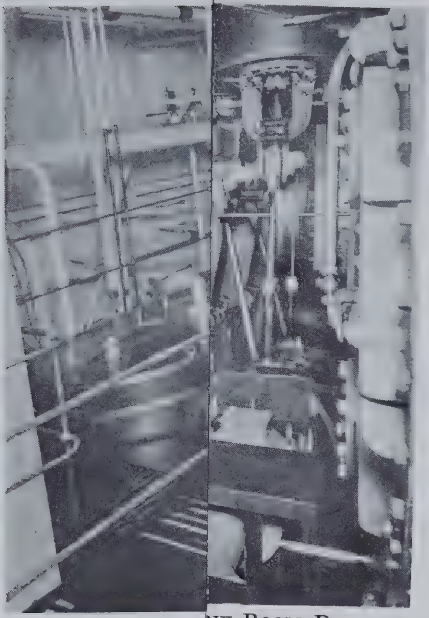

Fig. 18.—Gen ne Room Port.

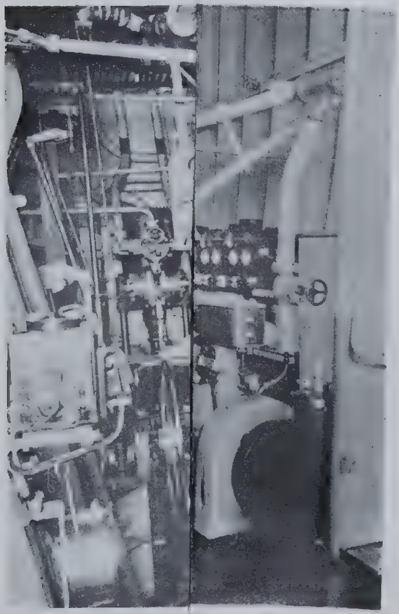

Fig. 20.—Gene Room Starboard.

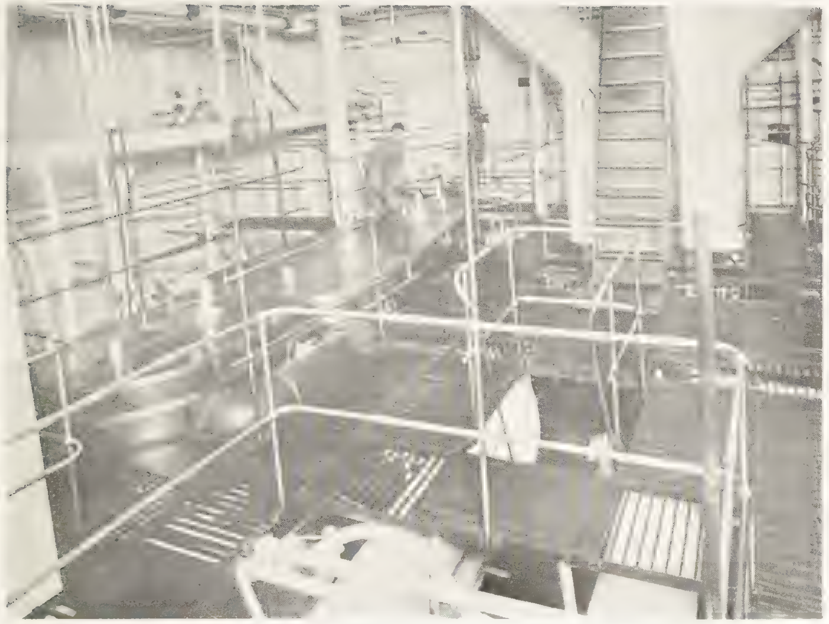

Fig. 18.—General view of the Propelling Engine Room Top.

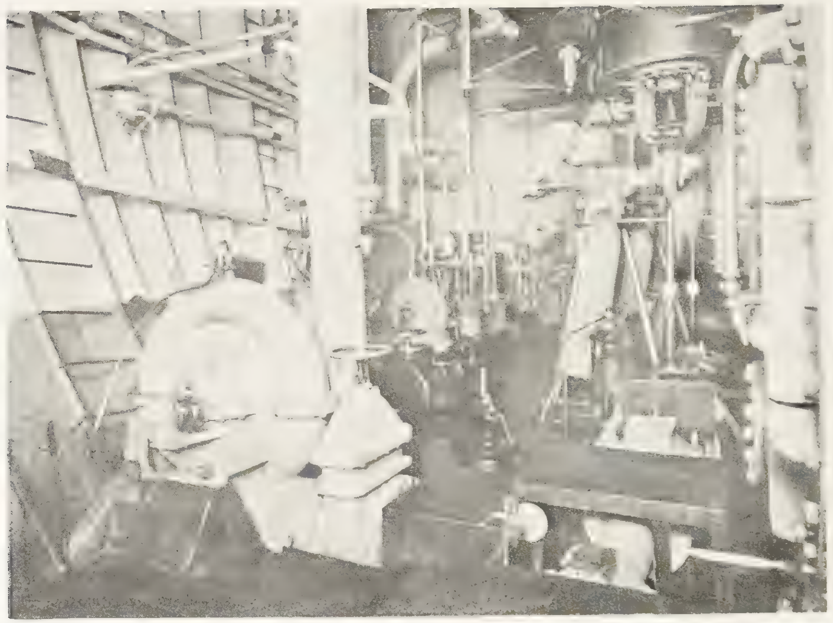

Fig. 19.—General view of the Propelling Engine Room Port.

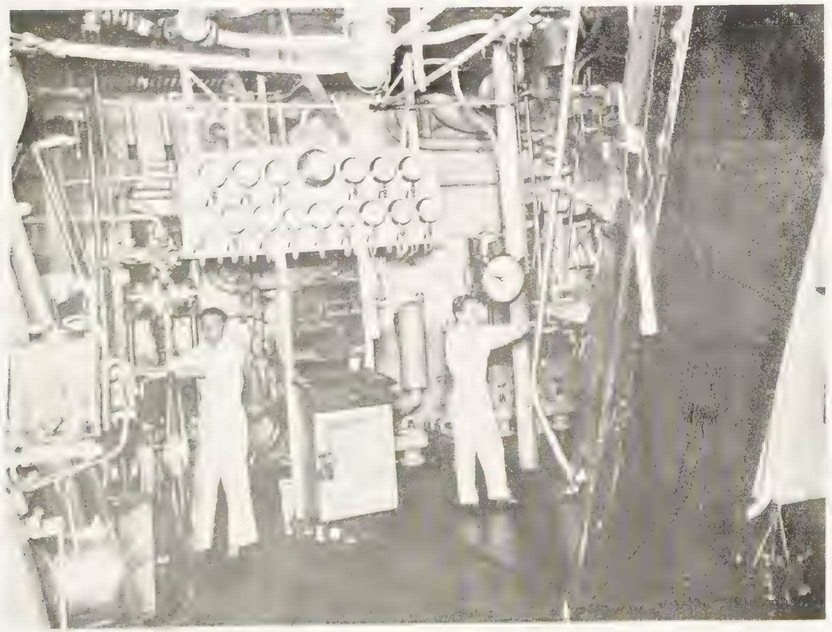

Fig. 20.—General view of the Propelling Engine Room Centre.

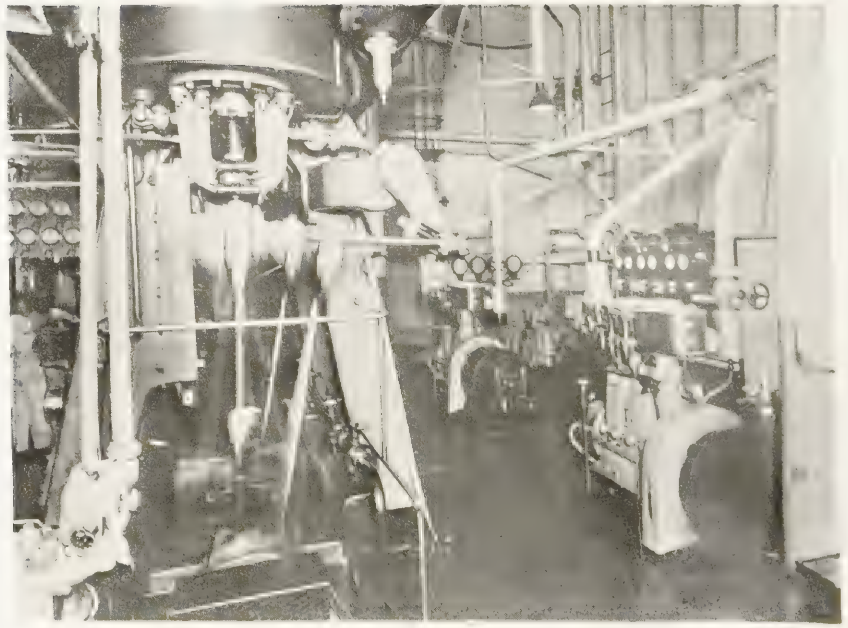

Fig. 21.—General view of the Propelling Engine Room Starboard.

The engine is of substantial construction, designed for a moderate degree of superheat, with crank shaft arranged in three interchangeable sections, ahead and astern valve motion and reversing gear, and fitted with a dead-weight sensitive governor. The Pistons are fitted with Lockwood and Carlisle packing rings, and the rods with patent metallic packing. The cylinders are well insulated and entirely enclosed by portable polished steel covers.

The pumping machinery which is installed in a separate engine room situated forward of the hopper spaces is entirely independent from the propelling machinery having its own condensing plant and auxiliary machinery which can be shut down when the dredging operations are suspended.

The pump room auxiliaries are all steam driven and comprise the following units:—

One Weir's Regenerative Condenser 3200 square feet constructed by the Builders, a "Weirs" Paragon type air pump, a 12" centrifugal circulating pump, a duplex cylinder condensate pump with automatic control from filter tank; Bilge, ballast and gland pressure water pumps, and as already mentioned the large high pressure water jet pump and a pair of powerful duplex pumps for the hydraulic pressure system.

On the starboard side of the pump room a well equipped workshop is arranged in a separate enclosure over which is situated a spacious pump room store. A general view of the pumping machinery and dredging pump is shown in Figs. 16. and 17.

PROPELLING MACHINERY.

The propelling machinery consists of twin sets of triple expansion surface condensing steam engines having cylinder 480—800—1300 m/m. diameter by 750 m/m. stroke, (18⅞″–31½″–51 $\frac{3}{16}$″ × 29½″) capable of developing a total of 3000 I. H. P. at a normal speed of 130 revs per minute. The working parts are designed for superheated steam. The engines are entirely independent for propelling purposes, with crank shafts in three interchangeable sections, fitted with "Michell" type patent thrust blocks, and driving four bladed cast iron propellers. All the pistons are fitted with Lockwood and Carlisle packing rings and the rods with patent metallic packing. The cylinders are well insulated and entirely enclosed on top with portable covers of planished steel sheets lined with asbestos material. The stern tube bushes are of cast iron fitted with Vicker's type sand excluding glands.

A large range of steam driven auxiliaries is provided for the feed water system and general service duties including:—One Weir's regenerative type condenser common to both engines having a cooling surface of 3200 sq. feet, constructed by the Builders, Weirs Main and auxiliary feed pumps with automatic feed control, Weir's "Paragon" type Air pump, Weir's 10 ton Evaporator and fresh water distilling apparatus, 12 inch centrifugal circulating pump; and the usual Bilge, Ballast and General service pumps. In addition an independent auxiliary condensing equipment is provided for port and stand-by use comprising:—A Weir's type condenser, "Mono-type" Air pump, and a 6 inch centrifugal circulating pump. A general idea of the arrangement of the Propelling engine room may be seen from Figs. 18 to 21.

The suction side of the feed water system connects to a gravitation type feed water filter of large capacity, into which the condensate water from the Pumping and Propelling engine room is directed together with drains from all the main and auxiliary machinery.

The feed water passes from the filter by automatic control to the main feed pumps and is discharged through a Weirs "Multiflow" type surface feed water heater before entering the Boilers.

A No. 6 "Hall's" CO_2 refrigerating machine is installed at the after end of the engine room adjoining the insulated chambers, while two vertical compound steam generating sets, supplied by the Builders, each driving a 16 K. W. Siemen's dynamo, together with a 12 K. W. "National,"—"Lawrence Scott" Emergency diesel dynamo set supplied by the National Gas and Oil Engine Co. Ltd., Ashton–under–Tyne, completes the auxiliary equipment in the propelling engine room.

BOILER ROOM INSTALLATION.

The steam generating equipment consists of four single–ended, cylindrical return tube, four furnace boilers each fitted with superheater and arranged for operating under Howden's system of forced draught in a common open stokehold, the furnace fronts being arranged for coal or oil fuel burning. The Boilers, superheaters, and fan units have been supplied by the Builders from their works at Elbing, the furnace fronts by Messrs. James Howden & Sons Ltd., Glasgow and the oil fuel equipment by The Wallsend Slipway & Engineering Co., Ltd., Wallsend–on–Tyne.

The Boilers are each 17′–1″ mean diameter x 12′–11″ mean length constructed with a single shell plate for a working pressure of 200 lbs. square inch, the steam being superheated to 610° F. in order to compensate for pressure drop in the long main steam range to the forward engine room. One of the four main boilers is shown under construction in Fig. 22. and a view of the after stokehold in Fig. 23.

The total heating surface of the four boiler is 13760 sq. feet, the grate area 328 sq. feet and the superheater surface 540 sq. feet. Each pair of boilers is fitted with a "Ranarex" CO_2 recorder, and two "See's" ash ejectors are installed for discharging the ashes. Soot blowing arrangements are fitted to each boiler. Under service conditions the Boilers are capable of supplying steam for all purposes, under natural draught condition when burning a good quality of Chinese coal having a calorific value of about 14000 B. T. Us per pound.

ELECTRICAL INSTALLATION.

The vessel is fitted throughout by electricity, the current being supplied from the steam generating sets installed in the propelling engine room. In addition to the deck and accommodation lights four powerful flood lights are fitted on posts over the dredging well for working at night, also a 6000 Watt searchlight is installed and arranged for working from the navigating bridge.

The main switch board is composed of polished "Sindanyo" panels built on a steel framework and arranged with the usual light and power circuits, switches and cut-outs. The instruments and fittings are of Siemen's make.

TRIALS AND DELIVERY

The keel of the "Chien She" was laid in the Danzig Yard of the Builders on the 1st March 1934 and on September the 15th, the vessel was successfully launched by Madame Liu Chung Chieh, wife of His Excellency the Chinese Minister at Berlin. Photographs 24 to 33 serve to indicate the very satisfactory progress made during construction.

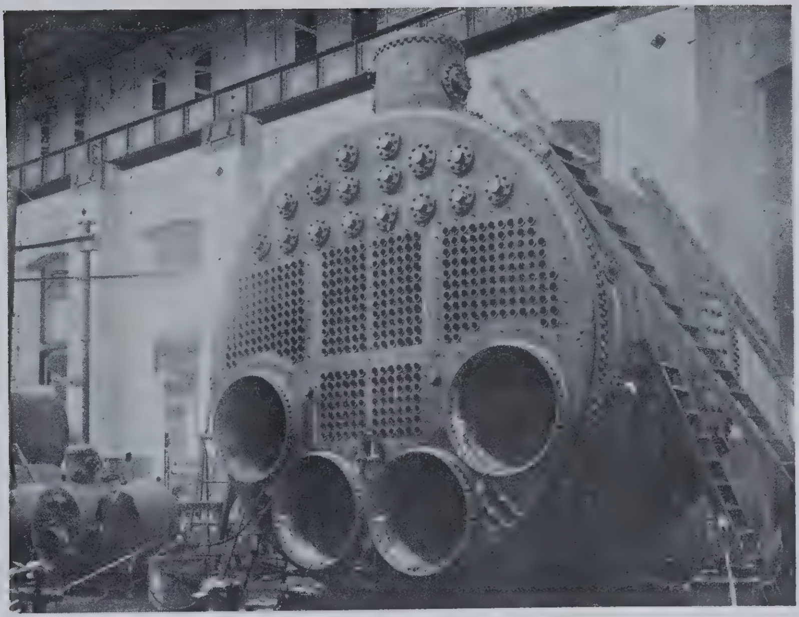

Fig. 22.—ONE OF THE FOUR BOILERS UNDER TEST.

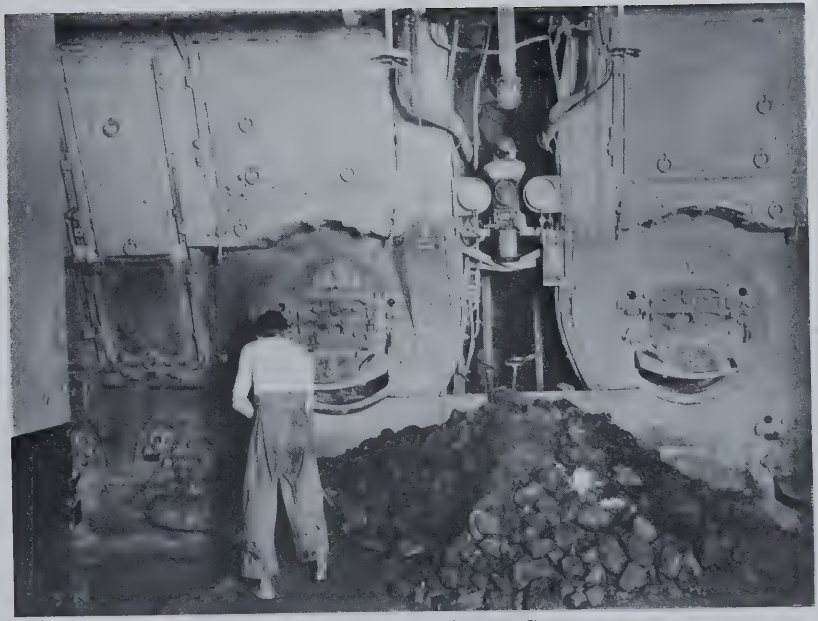

Fig. 23.—VIEW OF THE AFTER STOKEHOLD.

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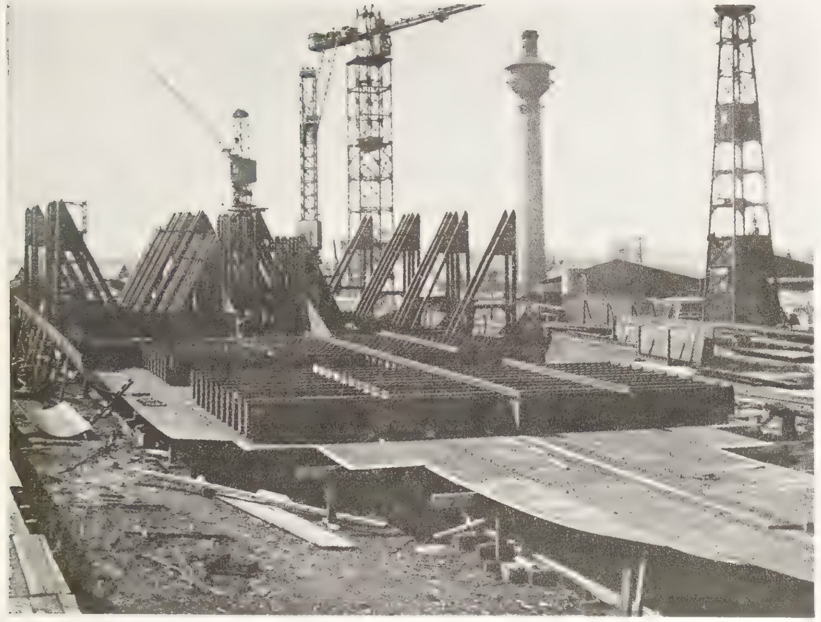

Fig. 24.—State of Progress 21/4/34.

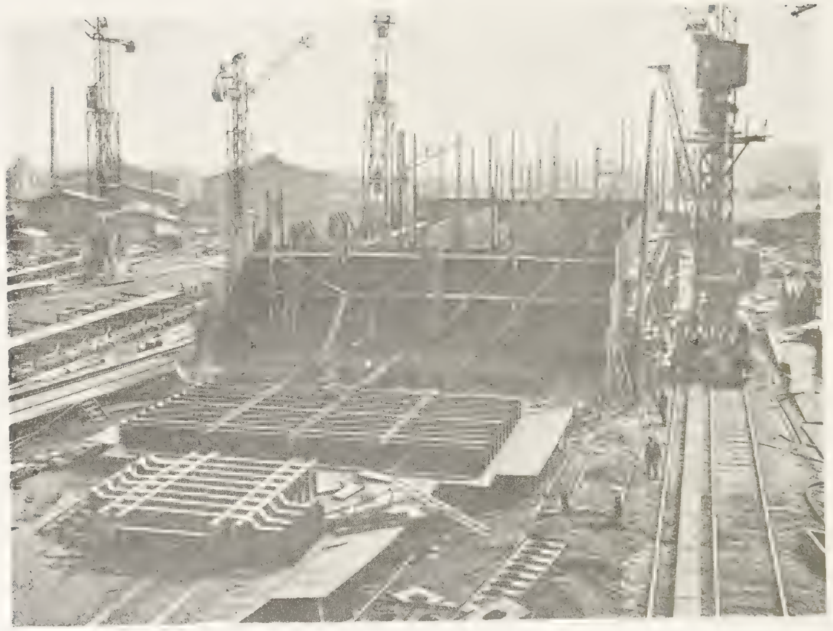

Fig. 25.—State of Progress 7/5/34.

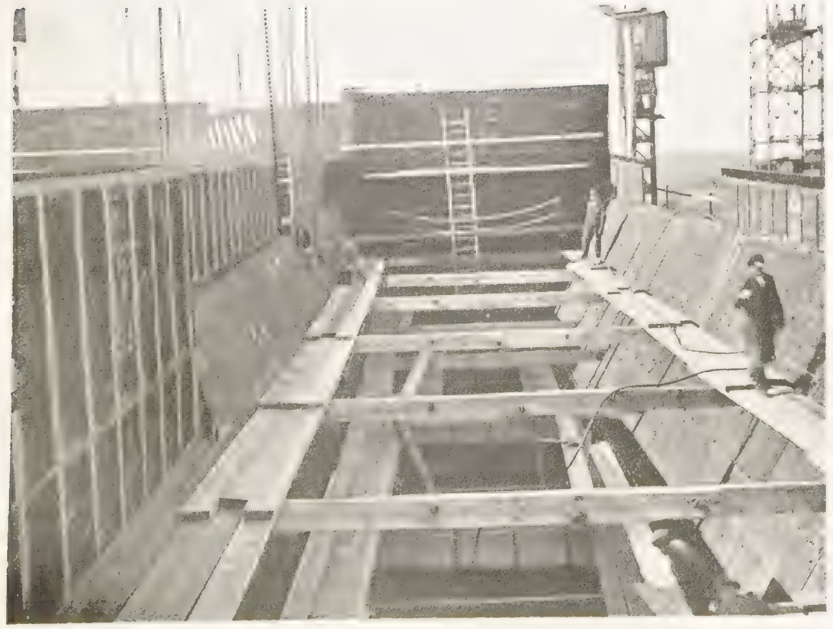

Fig. 26.—Plating of Starboard Hopper 7/6/34.

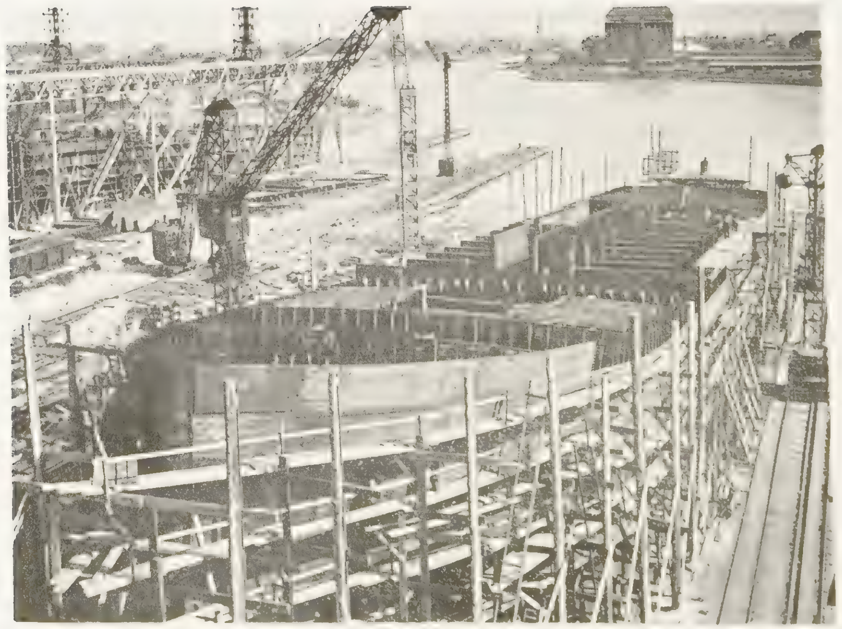

Fig. 27.—General view of the Dredger under construction 22/6/34.

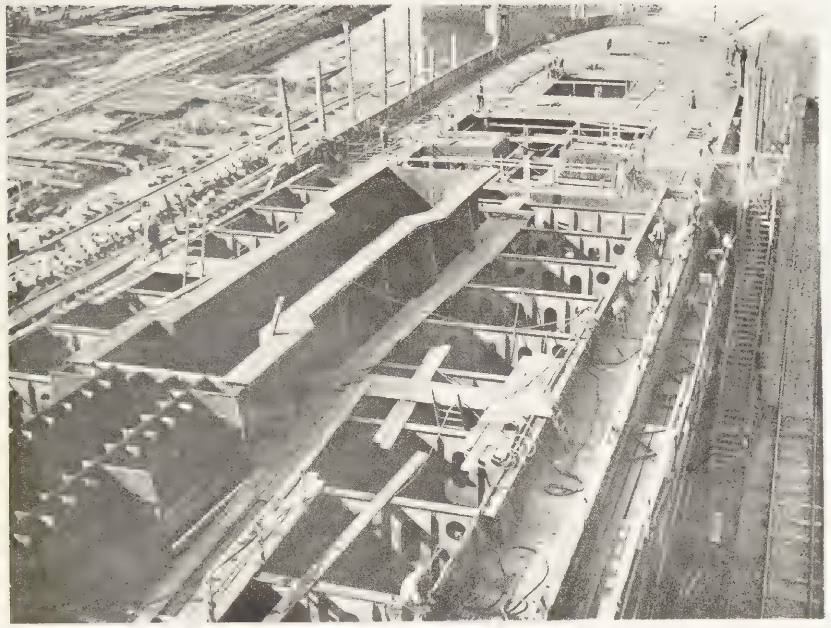

Fig. 28.—View showing Middle and After Body 26/7/34.

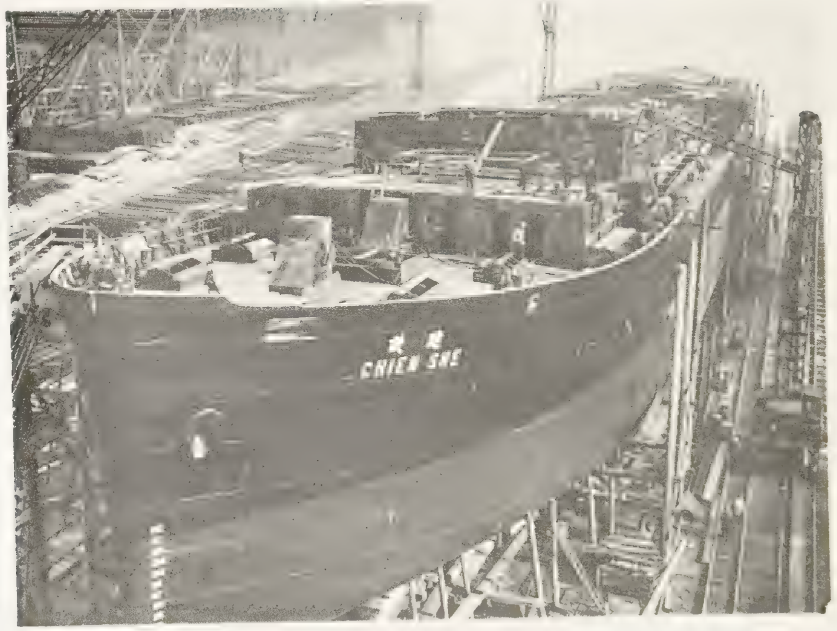

Fig. 29.—Dredger ready for Launching 7/9/34.

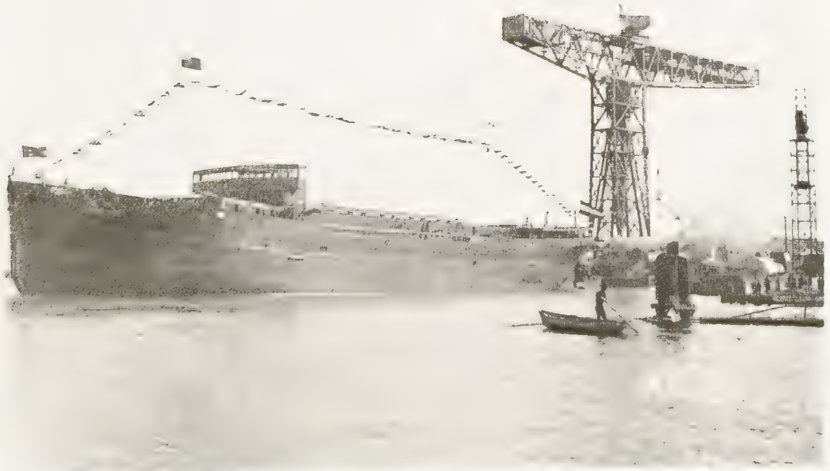

Fig. 30.—Dredger After Launching 15/9/34.

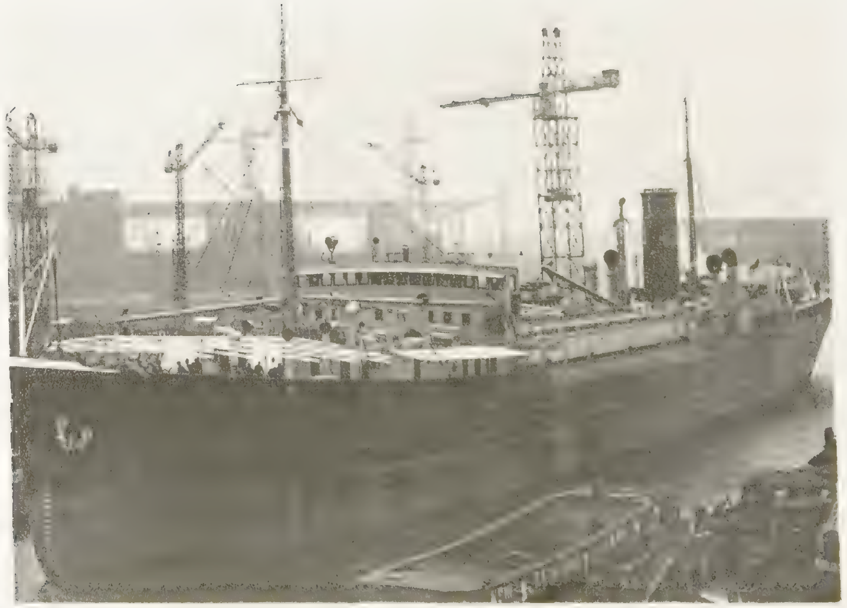

Fig. 31.—Dredger ready for Trials 11/12/34.

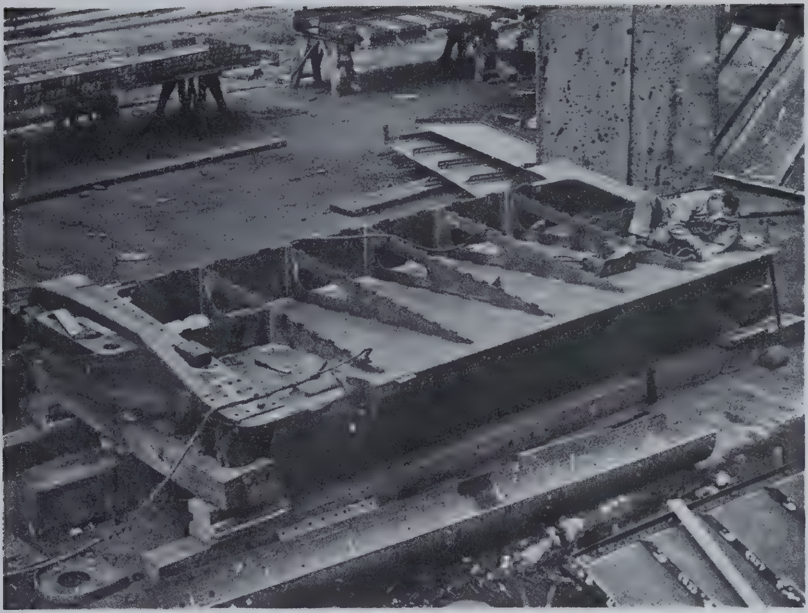

Fig. 32.—Rudder under construction.

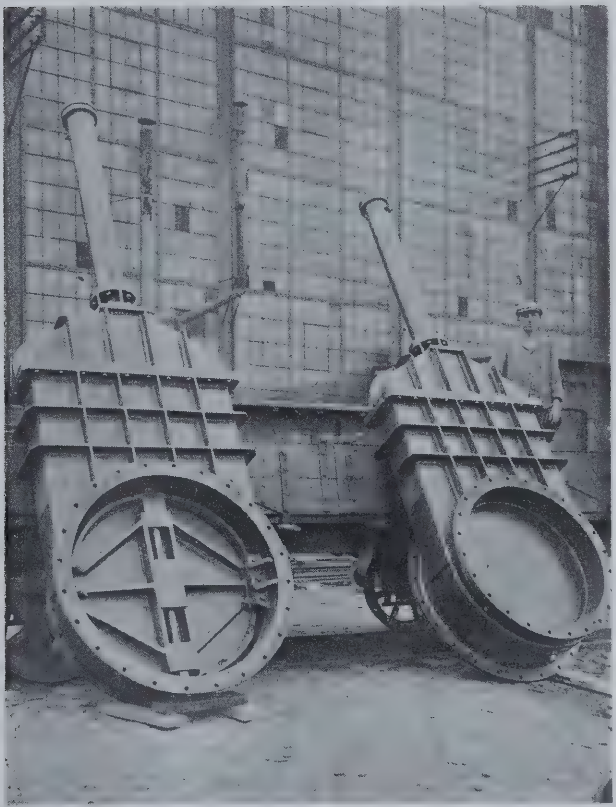

Fig. 33.—Welded Hydraulic Sluice Valves.

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Before leaving on the voyage to Shanghai the dredger carried out a series of preliminary dredging and speed trials at Pillau at the entrance to the Konigsberg Canal, in mid January, under unusually severe cold weather conditions.

The "Chien She" arrived at Shanghai on the 14th April 1935, and after docking for adjustment of the hopper doors and re-assembling of the dredging equipment the vessel was put into service condition and proceeded on official trials commencing on the 8th May 1935. The trials prescribed in the Board's agreements with the Builders were of a full and exhaustive nature covering a period of 100 hours dredging at the Tungsha Bar in the Yangtsze Estuary, Speed trials, Endurance trials, and Coal and Oil fuel consumption trials.

These were successfully completed within 10 days of the commencement, the vessel showing a highly satisfactory performance on all trials, as may be seen from the record of results in Table V, VI and VII.

Table V.—Summary of Results of Official Trials.

DESCRIPTION OF TRIAL	GUARANTEED	ACTUAL
Dredging Output in cubic yards, in-situ mud, per 10 hours dredging, including transport to dumping area	25,000 cub. yards	26,507 cub. yards
Coal consumption, dredging	2.1 lbs. per I.H.P.	1.77 lbs. per I.H.P.
Speed fully loaded	10.25 knots	11.188 knots
Speed in light condition	—	11.632 knots
Endurance trial, six hours steaming	Easy steaming at 10.25 knots	Satisfactory
Coal consumption steaming at 10.25 knots	—	1.98 lbs. per I.H.P.
Oil fuel consumption, dredging	—	1.104 lbs. per I.H.P.
Oil fuel consumption, steaming	—	1.293 lbs. per I.H.P.

Table VI.—Summary of Results of Progressive Speed Trials.

SPEED TRIALS LOADED				SPEEED TRIALS LIGHT			
Draft 18′-0″—Displacement 8400 tons				Draft 11′-7″—Displacement 5220 tons			
Run	Revs.	Speed knots	I.H.P.	Run	Revs.	Speed knots	I.H.P.
A	70	5.538	495	A	80	7.061	735
B	90	7.705	1087	B	100	8.806	1395
C	100	8.249	1415	C	120	10.752	2428
D	120	9.652	2268	D	135	11.632	3365
E	131	11.188	3293				
F	131						
G	131						

Speeds given are mean of means of runs with and against the tide.

Table VII.—Record of Output on 100 hours Dredging Trials.

OFFICIAL DREDGING TRIAL

DRAG SUCTION DREDGER "CHIEN-SHE"

RECORD OF OUTPUT

OUTPUT IN CUBIC METRES IN SITU MATERIAL DREDGED AS ASCERTAINED FROM CHART FOR 1.8 DENSITY

	Date of Trial....... ...	8th May	9th May	10th May	11th May	12th May	14th May	15th May	16th May	17th May	18th May	REMARKS
	Place of Trial	Tung-Sha Bar-Yangtsze Estuary-South of a Line between the lower mark buoy and Tung-Sha Buoy.										
	Dredging Time	11.48-5.30	8.07-5.56	8.28-6.44	8.07-6.18	6.13-3.33	7.10-6.36	6.57-6.33	7.03-6.43	6.44-6.39	6.03-3.31	
	Working Hours	4*h*. 47*m*.	9*h*. 49*m*.	10*h*. 16*m*.	10*h*. 11*m*.	9*h*. 20*m*.	11*h*. 26*m*.	11*h*. 36*m*.	11*h*. 40*m*.	11*h*. 55*m*.	9*h*. 20*m*.	Total dredging time 100 hrs. 20 mins.
	Deadweight including Coal Water Stores, etc. in tons	C.440 W 498 938	C.400 W.488 888	C.370 W.478 848	C.344 W.464 808	C.314 W.447.5 761.5	C.276 W.404.5 680.5	C.246 W.382 628	C.215 W.357.5 572.5	C.182 W.334 516	C.149 W.302 451	
	Correction in Draft for Dead wt in Excess of Contract	+11″	+9″	+8″	+7″	+6″	+5″	+3″	+2″	+1″	—1″	
	Light Draft of Vessel before Loading	11′-6″	11′-4″	11′-3″	11′-0″	11′-0″	10′-10″	10′-9″	10′-7″	10′-7″	10′-6″	
	Load Draft of Vessel after Loading	19′-0″	18′-11″	18′-9″	18′-6″	18′-6″	18′-6″	18′-5″	18'-4″	18′-3″	18′-2″	
	Character of Material Dredged	Generally soft thick mud, casily pumpable-Loads marked thus :—* Slight proportion of hard black sand with large volume of water.										
Specific Gravity of Material Dredged Six samples taken from Draghead at commencement of test	A	1.644	1.625	1.662	1.633	1.638	1.641	1.646	1.624	1.661	1.618	Average 1.6392
	B	1.718	1.715	1.721	1.672	1.707	1.647	1.699	1.666	1.709	1.632	,, 1.6886
	MEAN	1.681	1.670	1.691	1.652	1.672	1.644	1.672	1.645	1.685	1.625	,, 1.6639
	No of Hopper Loads per day	5	13	12	13	13	16	16	16	15	13	Total 132 loads
	Mean Hopper Load in metric tons	3752	3856	3817	3798	3801	3862	3880	3966	3854	3853	Average 3844 metric tons
	Mean Density of Hopper Mixture	1.268	1.318	1.396	1.374	1.403	1.368	1.363	1.384	1.312	1.316	Average 1.3502
Mean Density of samples from	Distributors	—	—	1.650	1.625	1.528	1.696	1.634	1.651	1.658	1.627	,, 1.6336
	Middle of Hopper	—	—	—	1.502	1.474	1.486	1.465	1.492	1.476	1.526	,, 1.4887
	Top ,, ,,	—	1.222	1.215	1.106	1.183	1.183	1.191	1.215	1.183	1.204	,, 1.1891
AVERAGE	Distance to Dump in miles	1.73	1.79	1.74	1.77	1.80	1.80	1.62	1.65	1.70	1.63	,, 1.723 miles
	Speed in Knots During Dredging	—	—	2.00	2.77	3.40	3.38	2.74	3.24	3.70	3.50	,, 3.0913 knots
	Dredg. Depth Ft.	37′-6″	38′-6″	39′-0″	35-′0″	38′-0″	36′-3″	38′-0″	38′-0″	38′-0″	39′-0″	
AVERAGE TIME	Dredging minutes	17.3	16.7	22.5	21.5	19.0	19.0	18.0	18.8	20.4	18.4	,, 19.16 mins.
	Steaming to Dump minutes	15.6	16.2	12.0	11.4	12.3	11.3	11.0	11.3	12.6	12.0	,, 12.17 ,,
	Dumping minutes	About 4 minutes from time of dumping to commencements of raising doors										
	Returning to Cut minutes	23.4	15.4	15.8	13.1	10.7	11.7	13.0	11.9	14.0	11.6	,, 14.06 ,,
	Complete Cycle Cut to cut minutes	57.3	45.3	51.3	47.0	43.0	43.0	43.0	43.0	48.0	43.0	,, 46.39 ,,
PARTICULARS OF 100 HOURS DREDGING TRIAL	Load No. 1	1050	1560	* 860	1240	1350	* 960	* 910	1225	1400	* 970	
	,, ,, 2	1000	1030	1503	1400	1385	1100	1000	1150	1250	1145	
	,, ,, 3	* 550	1200	1630	1400	1385	1250	* 920	1120	1220	1330	
	,, ,, 4	1200	1220	1360	1425	1350	1330	*1025	1400	1220	1150	
	,, ,, 5	1290	1170	*1040	1240	1420	1400	1125	1300	*1010	1080	
	,, ,, 6	—	1075	1520	1300	1400	1360	1400	1200	1180	1050	
	,, ,, 7	—	1250	1400	1200	1350	1425	1350	1320	1165	1060	
	,, ,, 8	—	1200	1540	1330	1425	1140	1550	1510	1225	1070	
	,, ,, 9	—	* 850	1400	1160	1470	1450	1520	1370	1130	1250	
	,, ,, 10	—	1200	1540	1110	1280	1500	1450	1450	1300	1160	
	,, ,, 11	—	1000	1250	1350	1380	1220	1104	1430	1130	1190	
	,, ,, 12	—	1175	1220	1300	1320	1450	1550	1375	*1040	1230	
	,, ,, 13	—	1370	—	1425	1380	1360	1450	1550	1130	1490	
	,, ,, 14	—	—	—	—	—	1370	1400	1510	1030	—	
	,, ,, 15	—	—	—	—	—	1290	1340	1440	* 940	—	
	,, ,, 16	—	—	—	—	—	1210	1280	1400	—	—	
	Total Output in cubic metres for density 1.8	5090	15300	16263	16880	17895	20815	20374	21750	17370	15175	
	Correction Factor for mean Sp. Gravity from draghd. samples	1.18	1.19	1.16	1.23	1.19	1.25	1.19	1.25	1.18	1.29	
	Total Output in cubic metres corrected for density	6006	18207	18865	20762	21295	26019	24245	27187	20496	19575	202657cu.metres Total
	Average Load per Cycle in cub. metres	1201	1400	1572	1597	1638	1626	1515	1699	1366	1506	
	Total Output in cubic yards corrected for density	7856	23815	24675	27157	27854	34033	31712	35561	26809	25604	265076 cu.yds. Total
	Average Load per cycle in cubic yards	1571	1832	2056	2089	2143	2127	1982	2222	1787	1969	

Contract Conditions :—Maximum draft in salt water with raised suction pipe and with hoppers full of spoil 350 tons coal in bunkers 150 tons fresh water in tanks, all stores and equipment and effects on board not to exceed 18′-0″.

Guaranteed dredging output of solid in situ material from the Yangtsze Bar of a density not more than 1.8 metric tons per cubic metre in situ dredged, transported in hoppers, deposited by hopper doors 2 sea miles distant from dredging base and the dredger returned to the dredging base in a total working time of 10 hours for an average of 100 working hours to be not less than 25000 cubic yards.

The Dredger "Chien She" was officially accepted by the Board as from the 3rd July 1935 and thereafter was commissioned for service commencing regular dredging operations at the Tungsha Bar on the 8th July 1935.

PROGRESS OF THE DREDGING OPERATIONS AT THE YANGTSZE BAR

It was clearly demonstrated by the satisfactory performance of the Dredger "Chien She" on the Official trials and preliminary dredging operations at the Bar that the Whangpoo Conservancy Board has been particularly fortunate in the choice of this type of Dredger for the important undertaking of dredging the Yangtsze Bar.

The mud, clay and sand materials comprising the Bar can be readily excavated, and further, the centre-well disposition of the Draghead which has been incorporated in the design has proved eminently suitable for the tidal and weather conditions at the dredging site, the dredger "Chien She" being exceptionally easy to manoeuver in the prevailing cross currents when dredging at a speed of about three knots over the ground.

During the period the "Chien She" has been on service up until the end of July 1936, a quantity of 4,296,110 cubic yards of material has been dredged from the crest of the Bar, and deposited on the dumping area about two miles distant from the dredging cut, in a total time of 2271 working hours, resulting in a deepening of the channel of about three feet over a width of 600 feet and a distance of three miles.

This remarkable achievement is considered highly satisfactory in view of the fact that over 60 per cent of the output consisted of hard sand which is not only difficult to dredge but quickly settles in the mixture resulting in a low average hopper density.

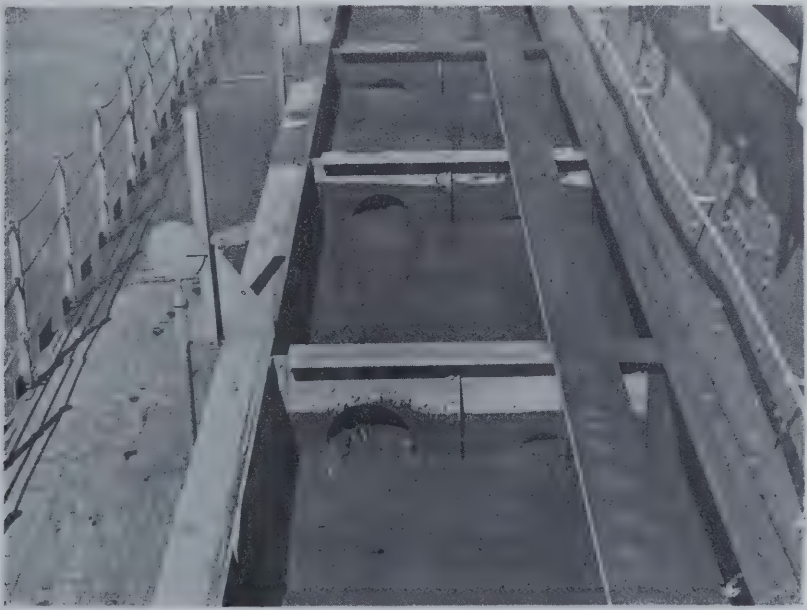

Fig. 40.—Hopper Load of Thick Mud.

The situation of the line of dredging is shown on the chart of the Yangtsze Estuary Plates Nos. I and VI, and the small scale sounding diagram Plate No. VII, gives a clear indication of the work already accomplished in accordance with the output records given above.

The photographs shown in Figs. 34 to 40 illustrate some interesting details of the dredger and the working operations, particularly Fig. 40. which shows a hopper load of thick mud having a mixture density of over 1.5 sp. gravity, dredged from the Yangtsze Bar.

Table VIII—Particulars of the five largest dredgers.

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Name of Dredger	"Leviathan"	"Chien She"	"Pierre Lefort"	M.O.P.217c	"Rietbok"
Year Built	1909	1935	1934	1929	1930
Builders	Cammel Laird	Schichau	Deschimag	Werf Gusto	Simons
Length B. P.	465’-9″	360’-0″	337’-0″	325’-0″	374’-0″
Beam Moulded	69’-0″	60’-0″	54’-0″	52’-6″	57’-9″
Depth Moulded	30’-7″	26’-6″	26’-0″	23’-0″	25’-9″
Designed loaded draft	23’-0″	18’-0″	19’-0″	18’-0″	18’-0″
Material designed for	Sand	Firm Mud	Various	Light Mud	Sand
Type of Dredger	Moored Suction Flexible head	Drag Suction Scooping head	Trailing Suction flexible head	Drag Suction Scooping head	Moored Suction Flexible head
Hopper Capy, to Deck Level cub. yds.	6700	3700	2610	2610	3700
Dredging rate in cub. yds. hour	8000	Normal. 8000	3300	8000 Contract (14000 Trials)	4000
Number and size of Suction pipes	4@ 42″	1 @ 43″	2 @ 25½″	1 @ 37″	1 @ 42″
I.H.P. of Pumping Engines	2800	2400	2000	2000	1350
I.H.P. of Propelling Engines	4000	3000	3000	2000	3000
Total I.H.P. of main Machinery	6800	5400	5000	4000	4350
Type of Machinery	Steam	Steam	Diesel Electric	Steam	Steam
Speed in knots, loaded	10.5	11.0	11.0	9.0	11.5
Maximum Dredging Depth in. ft.	70’	45’	65’	50’	No inform.
Location of service	Mersey Bar	Yangtsze Bar	Bordeaux Bar	Punto Indio	Durban Bar.

The above table No. VIII gives the principal characteristics of five of the largest Bar dredgers now in operation, from which it will be seen that the Dredger "Chien She" is the largest and most powerful of the Drag Suction type which has yet been constructed.

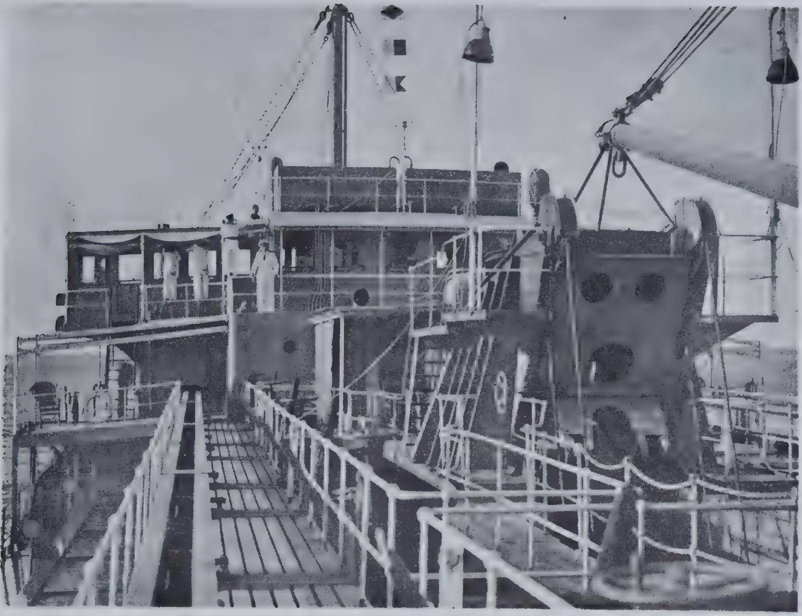

Fig. 34.—General view of Dredger looking Forward.

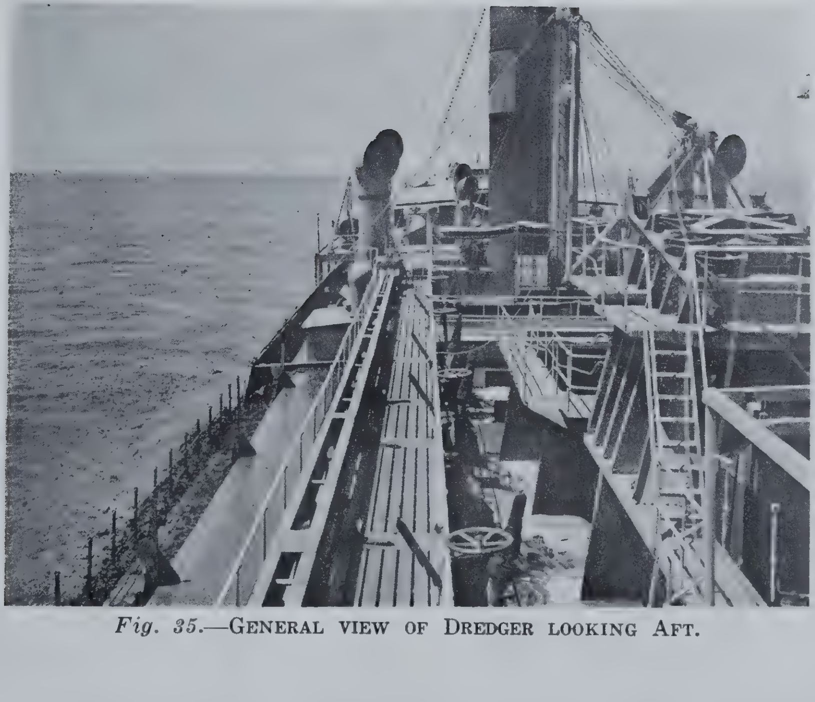

Fig. 35.—General view of Dredger looking Aft.

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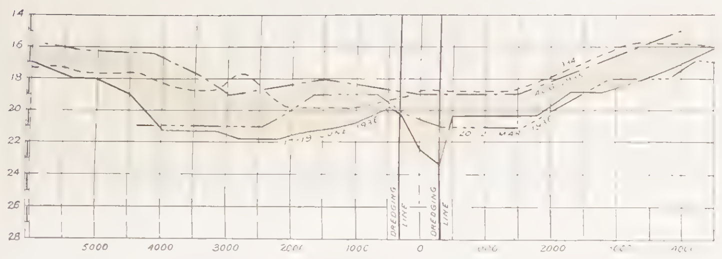
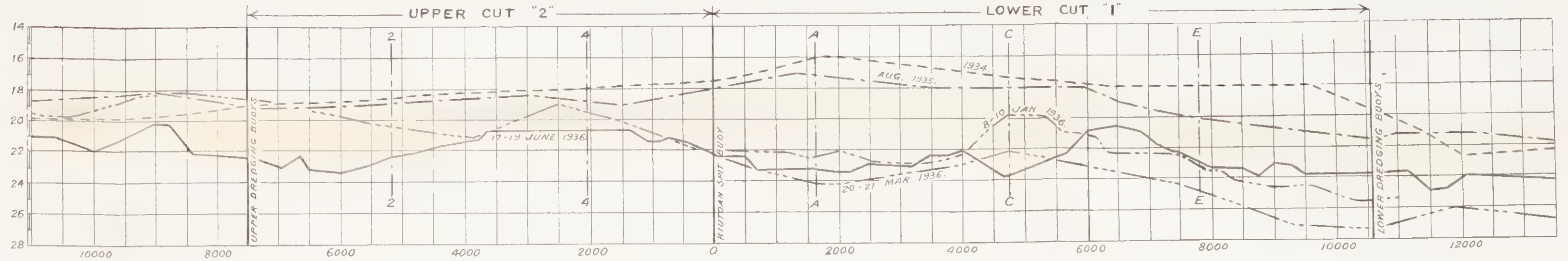
Plate VII.

YANGTSE BAR DREDGING
KIUTOAN SPIT BUOY DREDGING CUT

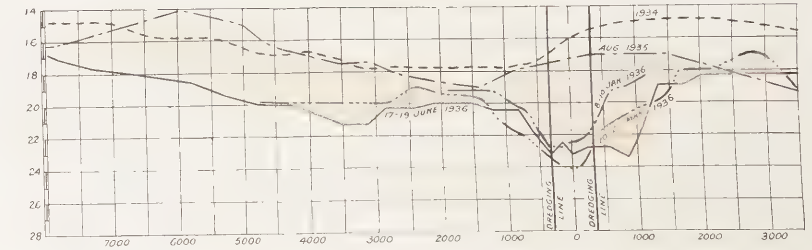


SECTION 2-2

DREDGING DONE DURING MAY 1935 – JUNE 1936

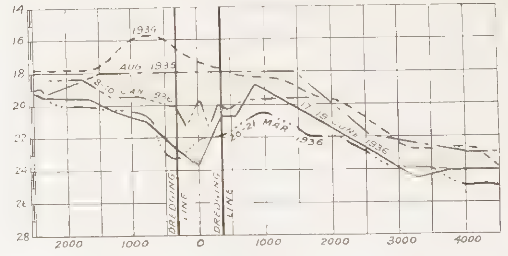


LONGITUDINAL SECTION OF CENTRE LINE

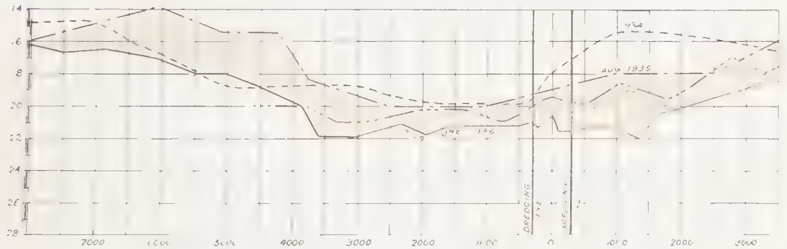


SECTION A-A

SCALE { HORIZONTAL 1 IN. = 2000 FT
VERTICAL 1 IN. = 8 FT



SECTION C-C



SECTION 4-4

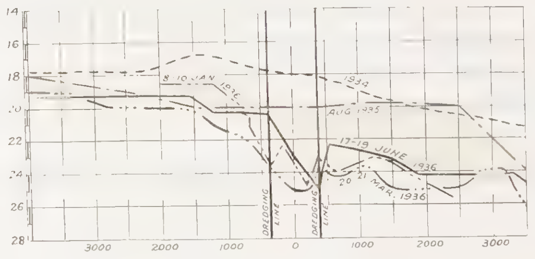
- - - - - - - - SOUNDINGS TAKEN 1934 REDUCED TO THE LEVEL OF LOWEST POSSIBLE LOW WATER

—— - —— - —— SOUNDINGS TAKEN AUG. 1935 REDUCED TO MIDDLE DREDGING TIDE GAUGE ZERO

—— - - —— - - —— SOUNDINGS TAKEN 8-10 JAN. 1936 " " " " " " "

—— - - - —— SOUNDINGS TAKEN 20-21 MAR 1936 " " " " " " "

———————— SOUNDINGS TAKEN 17-19 JUNE 1936 " " " " " " "



SECTION E-E

▭ DREDGING DONE DURING PREVIOUS QUARTERS, REMAINING.

▭ DREDGING DONE DURING 2ND QUARTER 1936.

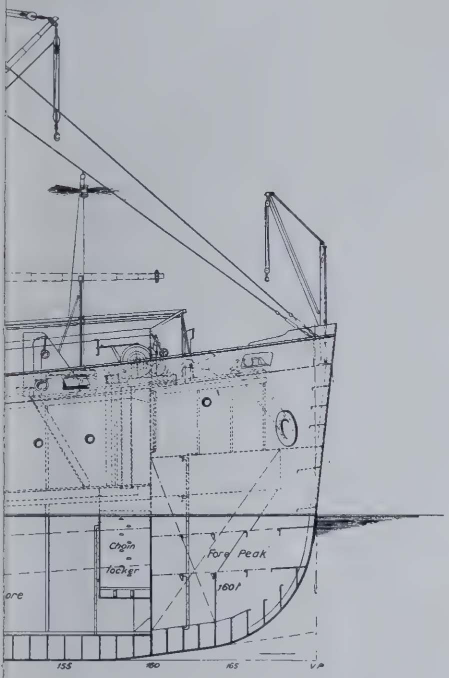
SHANGHAI 14TH JULY 1936

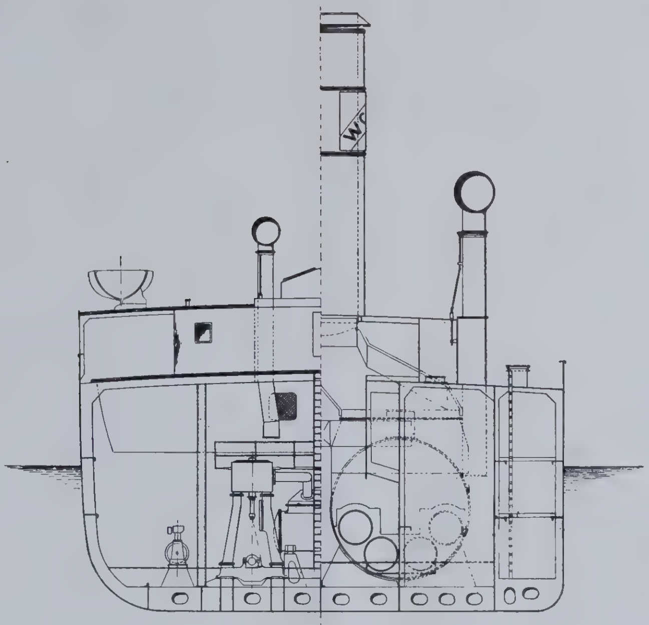
Herbert Chatley

ENGINEER – IN – CHIEF

DRAWING No. R. 212/1836

Plate II.

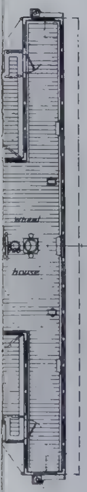




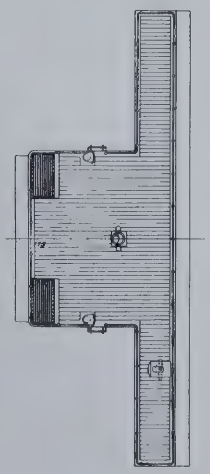
Section on

frame 35 *frame 52*

ating bridge.



Flying bridge.



WHANGPOO CONSERVANCY BOARD

"CHIEN SHE"

TWIN SCREW DRAG SUCTION HOPPER DREDGER

WITH CENTRAL WELL

ELEVATION AND SUPER STRUCTURES

1:100

Main Dimensions.

Length between perpendiculars	*360'0" - 109,726 m*
Breadth moulded	*60'0" - 18,288 "*
Depth "	*26'6" - 8,077 "*
Maximum draught	*18'0" - 5,486 "*
Maximum dredging depth	*45'0" - 13,716 "*

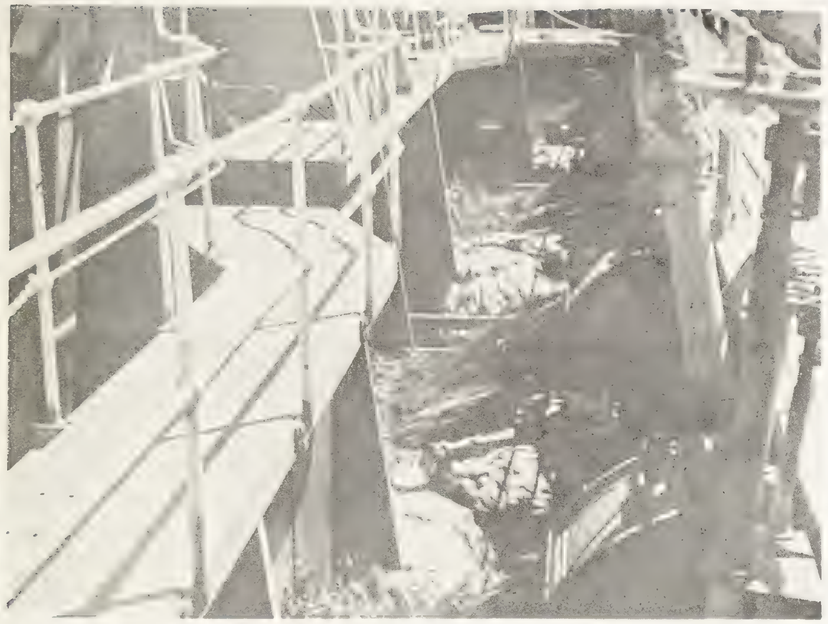


Fig. 36.—Filling mud to Port Hoppers through Distributor Outlets.

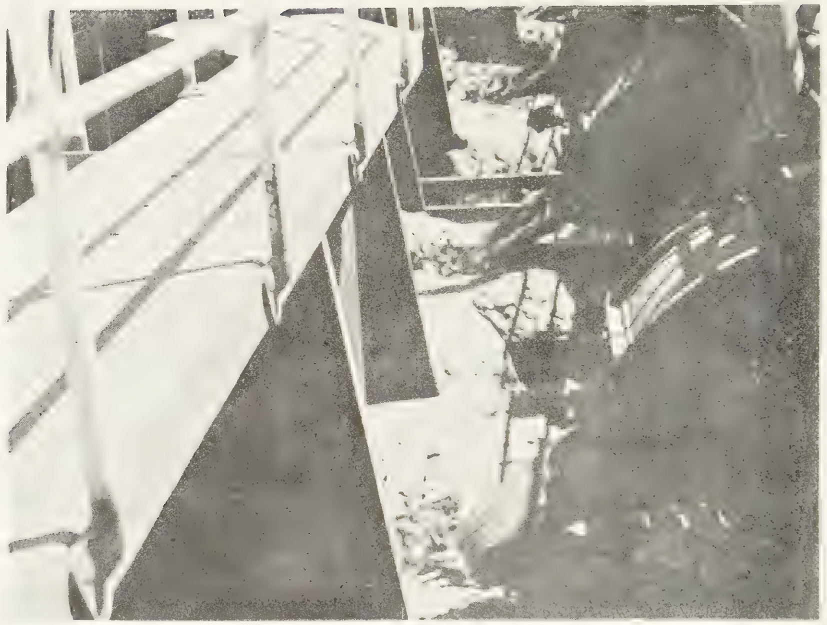


Fig. 37.—Filling mud to Port Hoppers through Distributor Outlets.

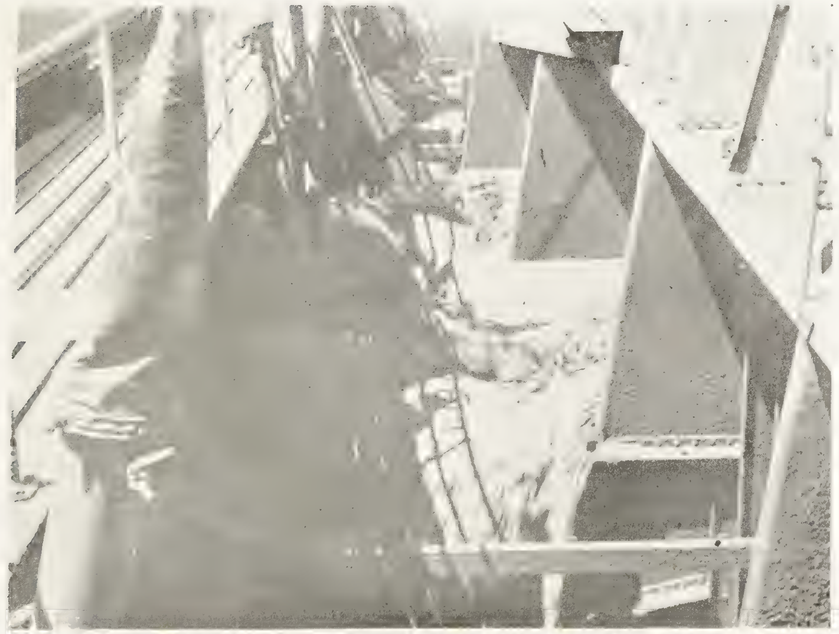


Fig. 38.—Filling mud to Starboard Hoppers through Distributor Outlets.

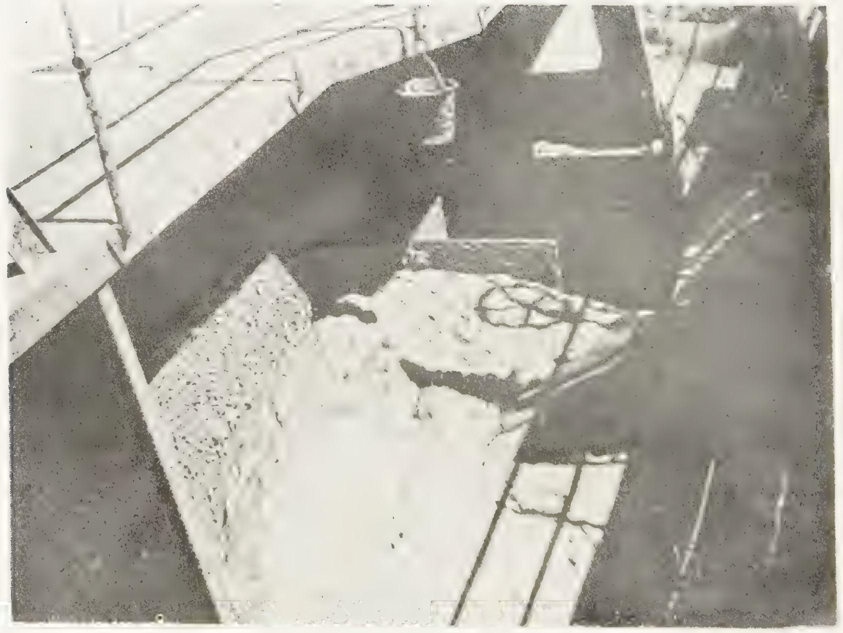
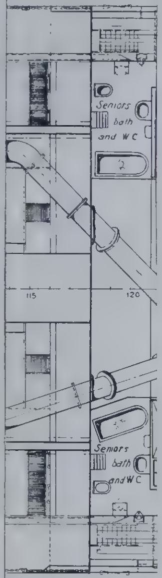


Fig. 39.—Filling mud to Starboard Hoppers through Distributor Outlets.


Seniors bath and W C
115
120
Seniors bath and W C

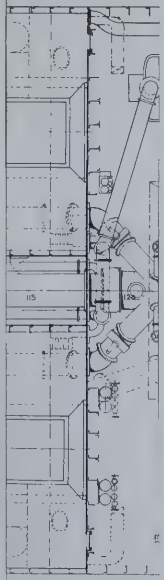
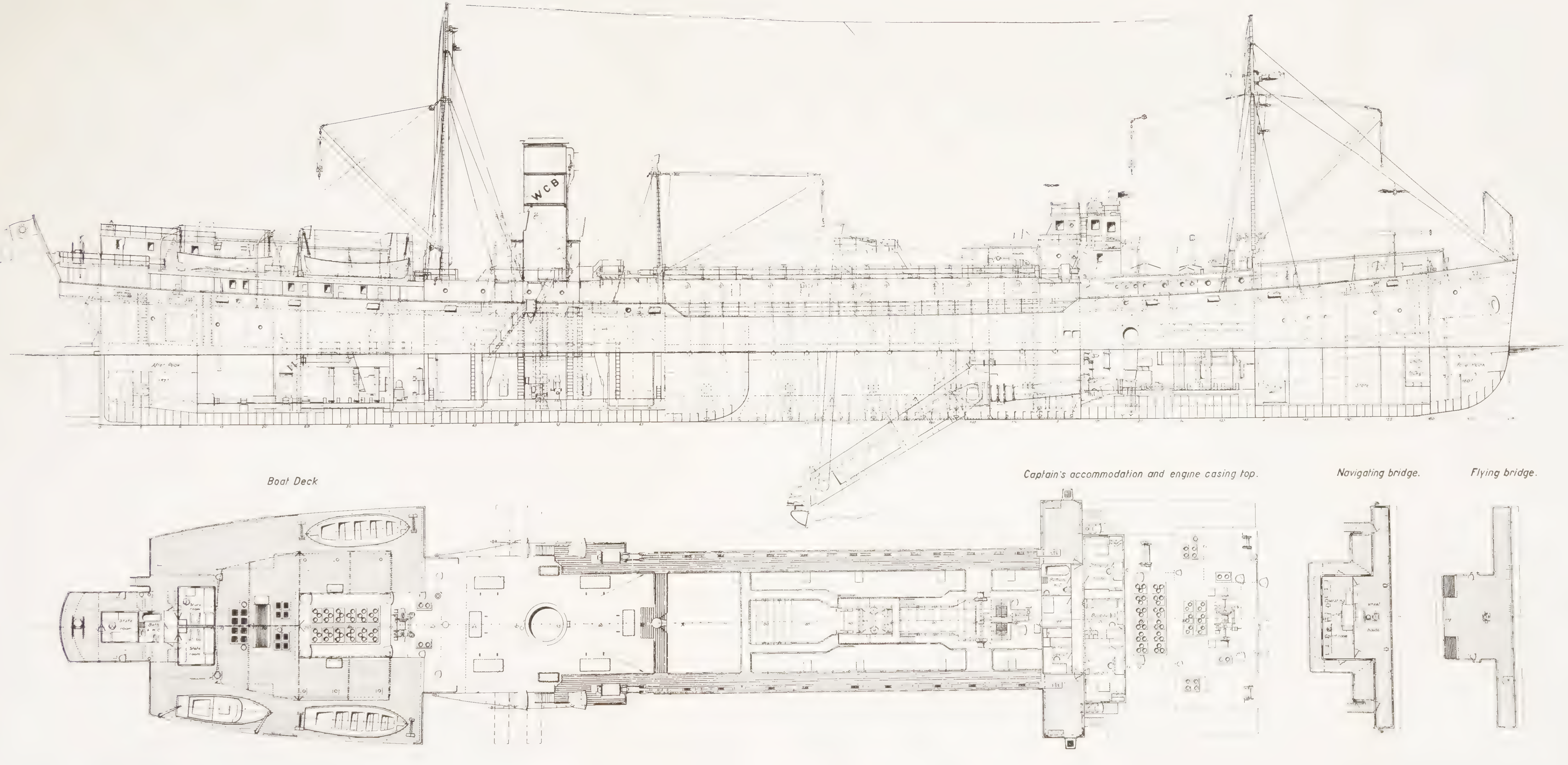
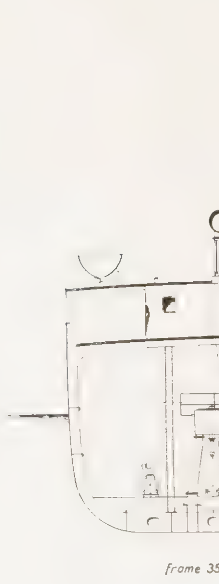

115
120

Plate II.





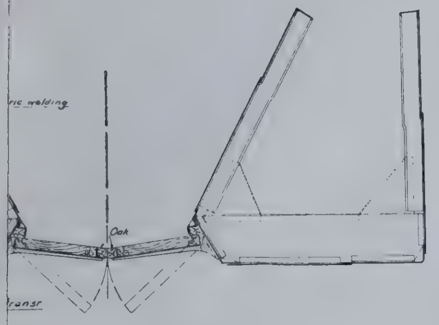
WHANGPOO CONSERVANCY BOARD
"CHIEN SHE"
TWIN SCREW DRAG SUCTION HOPPER DREDGER
WITH CENTRAL WELL
ELEVATION AND SUPER STRUCTURES

1:100

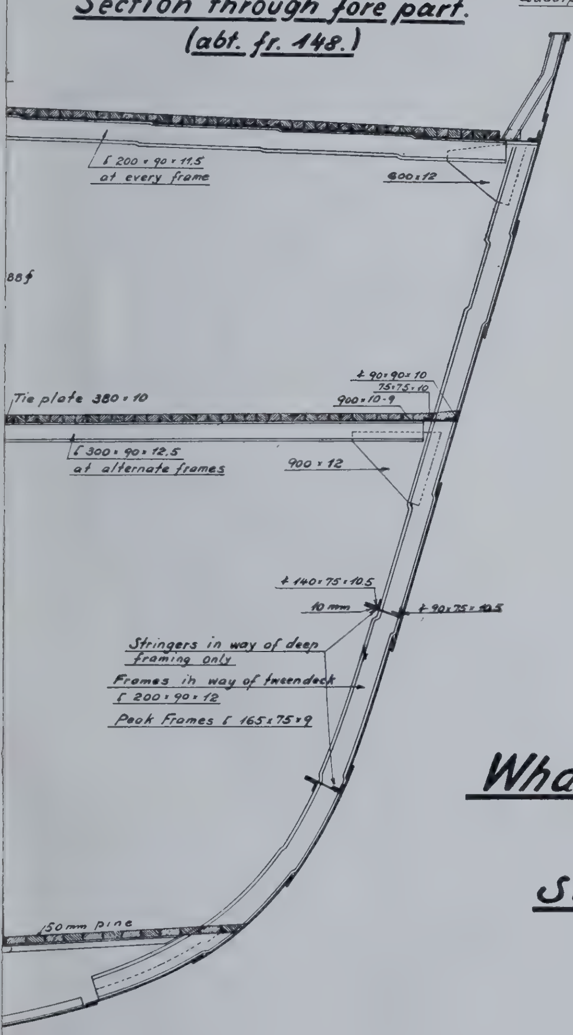
Main Dimensions.

Length between perpendiculars	*360'0" - 109,726 m*
Breadth moulded	*60'0" - 18,288 "*
Depth	*26'6" - 8,077 "*
Maximum draught	*18'0" - 5,486 "*
Maximum dredging depth	*45'0" - 13,716 "*

Plate IV.



Section through fore part.
(abt. fr. 148.)



In way of hopper
Treblestrap doubling stringer

Heavy top plate
Quadrpl R. overlaps

Riveting

	Endlaps amidsh			Endlaps at ends			Seams		
	Scheme	Diam mm	Spacg.	Scheme	Diam mm	Spacg	Scheme	Diam. mm	Spacg.
Flat plate keel	+++	22	3,5 d	+++	22	3,5 d	++	22	4 d
Shell fr. keel to upper t. of bilge	+++	22	3,5 d	+++	19	3,5 d	++	22-19	4 d
" " upper t. of bilge to strake									
below sheerst.	+++	22	3,5 d	+++	19	3,5 d	++	22-19	4 d
Strake below sheerstrake	++++	25	4 d	+++	19	3,5 d	+	25-19	4 d
Sheerstrake	+++++	25	4,5 d	+++	19	3,5 d	++	25-19	4 d
Upper deck stringer plate	++++	22-25	4 d	++	19	3,5 d	++	22-25	4,5 d
Upperdeck plating	++++	22-25	4 d	+	19"/16	3,5 d	+	19"/16	4,5 d
Tweendeck stringer plate				++	19	3,5 d			
Side plating of wall	++	19	4 d				+	19	4 d
Side plating of hoppers	++	19	4 d				+	19	4 d
Double bottom plating	++	19	4 d				+	19	4 d
Fuel oil bunker plating	++	19	3,5 d				+	19	3,5 d
Watertight bulkheads	+	19	4,5 d				+	19	4,5 d
End bulkheads of hoppers	+	19	4 d				+	19	4 d
Vertical and foundation									
plates of centre keelson	+++	19	4 d	++	19	4 d			
Floor plates and web frames	+++	19-22	4 d						

Anchors, chains and ropes.

Equipment number 31890, letter x.

3 special Hall bowers 2710 kg each
1 " " stream-anchor 950 "
2 stud chain cables 2⅛" diam, 247,5 m = 135 fathoms each
1 " " " 1¹³⁄₁₆" " 165 m = 90 "
1 towline, steelwire, 4½" circ., 220 m = 120 fathoms
2 hawsers, " , 2½" " , 165 " = 90 " each
2 warps, " , 2½" " , 165 " = 90 " "

Notice: Approved by Lloyds Register 11.12.33

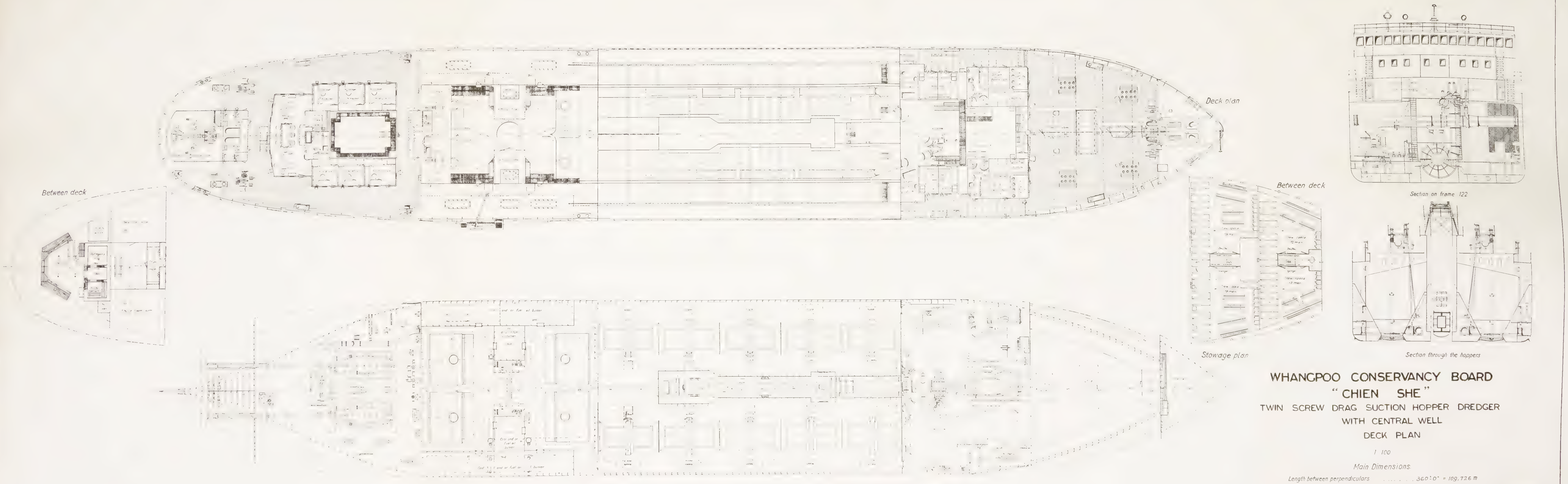
Whangpoo Conservancy Board
Twin-Screw-Steam-Suction-Hopper-Dredger.
"Chien-She."
Midship-Sections.

1:25, 1:5, 1:1.

Class: Lloyds Register ✠ 100 A1 Hopper Dredger.

Length betw. perpendiculars	360'0"	= 109,726 m
Breadth moulded	60'0"	= 18,288 "
Depth moulded	26'6"	= 8,077 "
Draught	18'0"	= 5,486 "

Plate III.



WHANGPOO CONSERVANCY BOARD
“CHIEN SHE”
TWIN SCREW DRAG SUCTION HOPPER DREDGER
WITH CENTRAL WELL
DECK PLAN

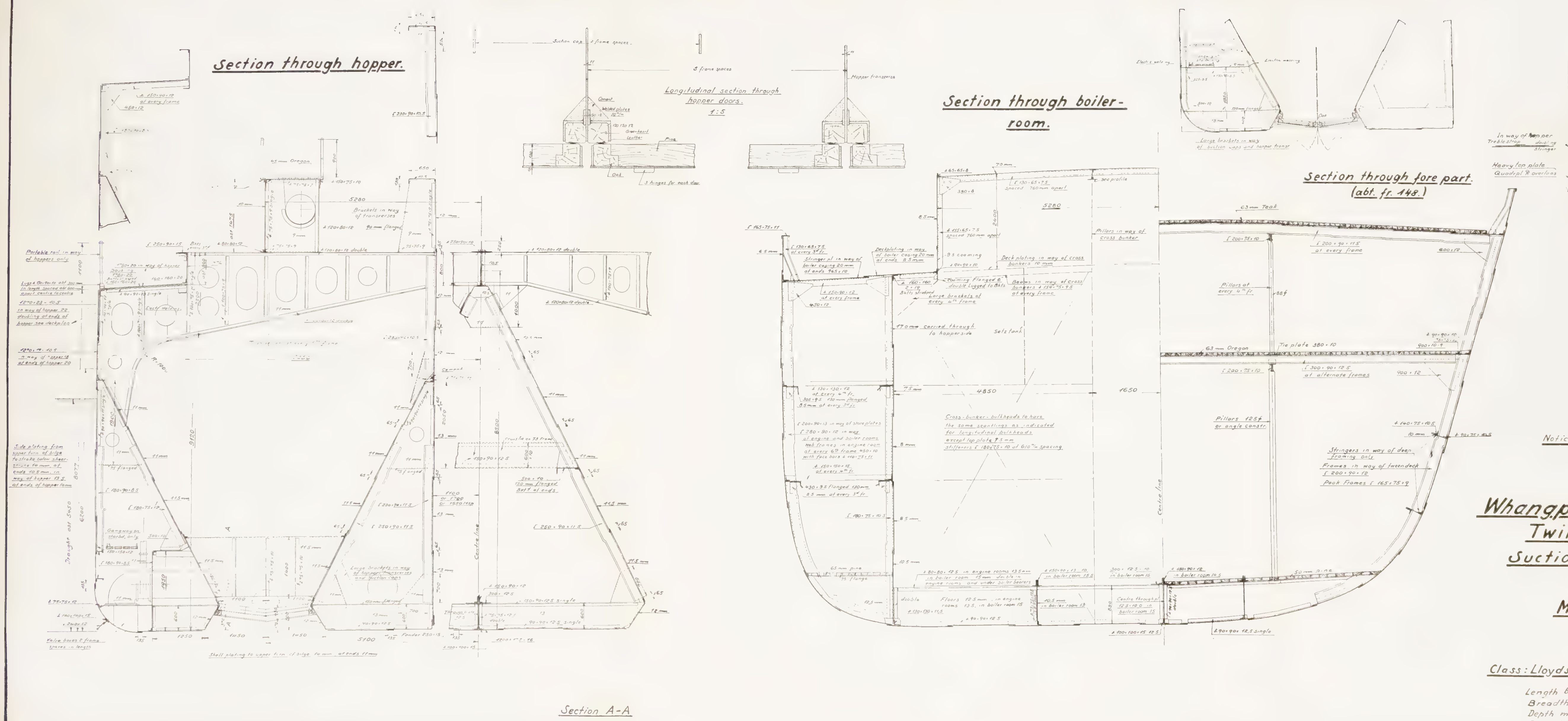
1 100

Main Dimensions.

Length between perpendiculars	360'0"	= 109,726 m
Breadth moulded	60'0"	= 18,288 "
Depth " "	26'6"	= 8,077 "
Maximum draught	18'0"	= 5,486 "
Maximum dredging depth	45'0"	= 13,716 "

WHANGPOO CONSERVANCY BO

Twin screw drag suction hopp
dredger with central well deck


Section through hopper.
Longitudinal section through hopper doors. 1:5
Section through boiler-room.
Section through fore part. (abt. fr. 148.)
Section A-A
Portable rail in way of hoppers only
Brackets in way of transverses
Centre line
Cross bunker bulkheads to have the same scantlings as indicated for longitudinal bulkheads
Large brackets in way of suction caps and hopper transv.
Pillars in way of cross bunker
Pillars at every 4th fr.
Pillars 125 ϕ
Stringers in way of deep framing only
Frames in way of tweendeck
Peak Frames
Tie plate 380 × 10
63 Oregon
63 Teak
In way of hopper Treble strap doubling Stringer
Heavy top plate Quadrpl. R overlaps
Shell plating to upper turn of bilge

Riveting

	Endlaps amidsh			Endlaps at ends			Seams		
	Scheme	Diam mm	Spacg	Scheme	Diam mm	Spacg	Scheme	Diam mm	Spacg
Flat plate keel	⧺	22	3.5d	⧺	22	3.5d	⧺	22	4d
Shell fr. keel to upper t. of bilge	⧺	22	3.5d	⧺	19	3.5d	⧺	22-19	4d
[illegible] sheerstr.	⧺	22	3.5d	⧺	19	3.5d	—	22 19	4d
Strake below sheerstrake	⧺	25	4d	⧺	19	3.5d	—	25 19	4d
Sheerstrake	⧺	25	4.5d	⧺	19	3.5d	—	25 19	4d
Upper deck stringer plate	⧺	22-25	4d	—	19	3.5d	—	22 25	4.5d
Upperdeck plating	⧺	22-25	4d	—	19 16	3.5d	—	19 16	4.5d
Tweendeck stringer plate				—	19	3.5d			
Side plating of well		19	4d				—	19	4d
Side plating of hoppers		19	4d				—	19	4d
Double bottom plating		19	4d				—	19	4d
Fuel oil bunker plating		19	3.5d				—	19	3.5d
Watertight bulkheads		19	4.5d				—	19	4.5d
End bulkheads of hoppers		19	4d				—	19	4d
Vertical and foundation plates of centre keelson		19	4d	—	19	4d			
Floor plates and web frames	⧺	19-22	4d						

Anchors, chains and ropes.

Equipment number 31890, letter X.

3 special Hall bowers 2710 kg each
1 " " stream anchor 950 "
2 stud chain cables 2⅛" diam, 247.5 m = 135 fathoms each
1 " " " 1 3/16" " 165 m = 90 "
1 towline, steelwire, 4½" circ, 220 m = 120 fathoms
2 hawsers, " , 2½" " , 165 " = 90 " each
2 warps, " , 2½" " , 165 " = 90 " "

Notice: Approved by Lloyds Register 11.12.33

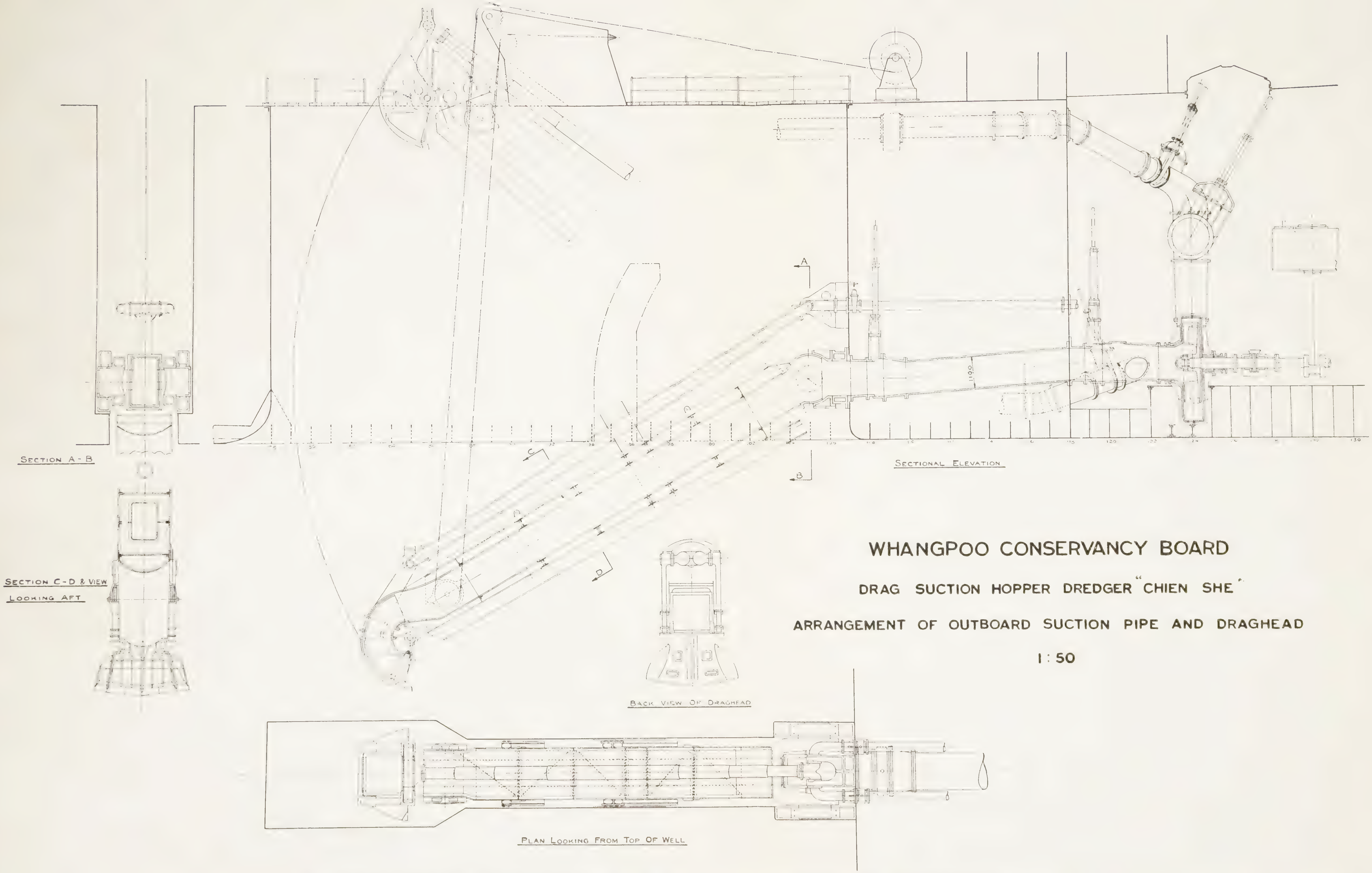
Whangpoo Conservancy Board
Twin-Screw-Steam-
Suction-Hopper-Dredger.
"Chien-She."
Midship-Sections.

1:25, 1:5, 1:1.

Class: Lloyds Register ✠ 100 A1 Hopper Dredger.

Length betw. perpendiculars	360'0" = 109.726 m
Breadth moulded	60'0" = 18.288 "
Depth moulded	26'6" = 8.077 "
Draught	18'0" = 5.486 "

Plate V.


Section A - B
Section C - D & View Looking Aft
Sectional Elevation
A
B
C
D
1190
Back View Of Draghead
Plan Looking From Top Of Well

WHANGPOO CONSERVANCY BOARD

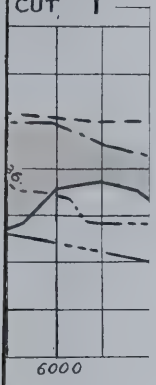
DRAG SUCTION HOPPER DREDGER "CHIEN SHE"

ARRANGEMENT OF OUTBOARD SUCTION PIPE AND DRAGHEAD

1 : 50

1936

CUT "I"



LE LOW WA

GAUGE Z

”

”

”

Plate VI.

上海濬浦局疏濬揚子江口神灘審定初步地點圖

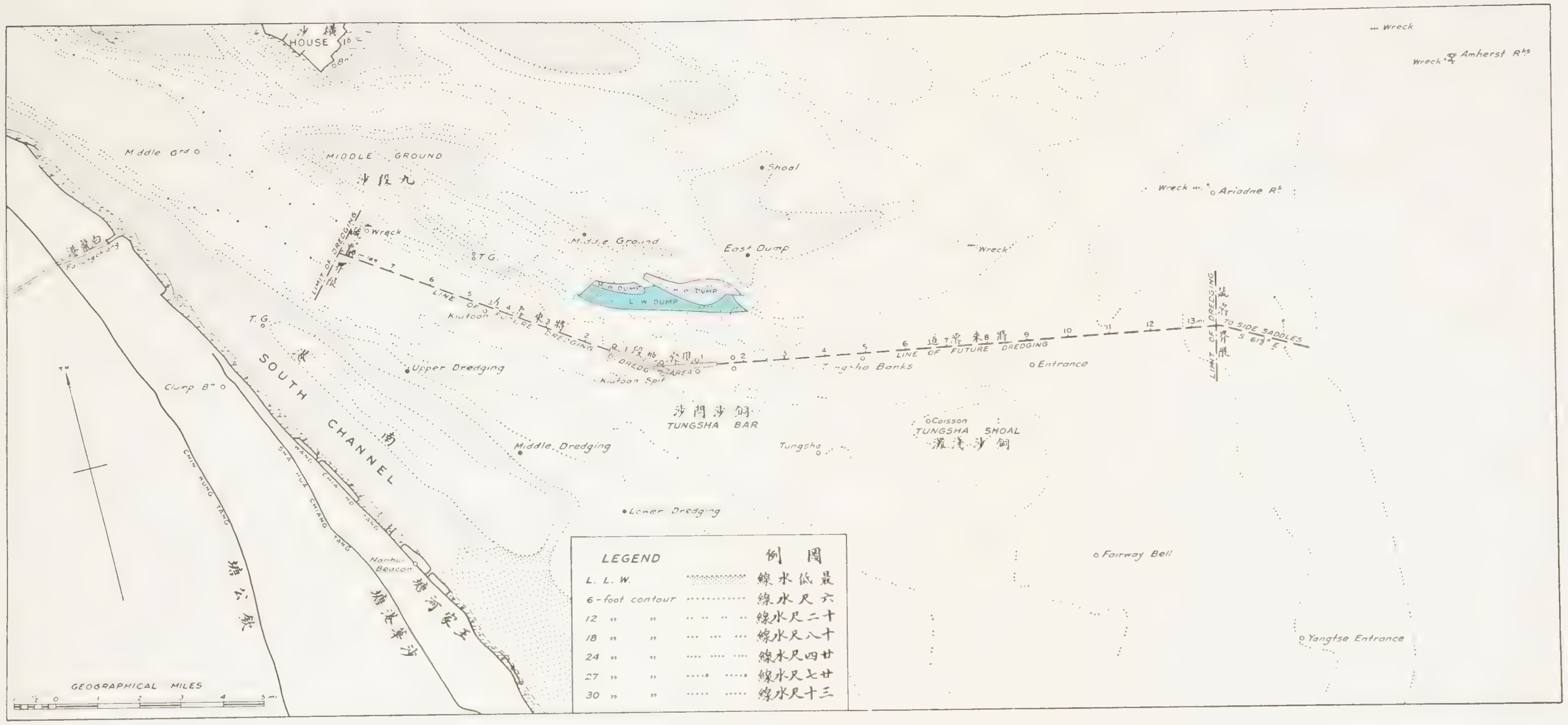
民國二十三年測

WHANGPOO CONSERVANCY BOARD

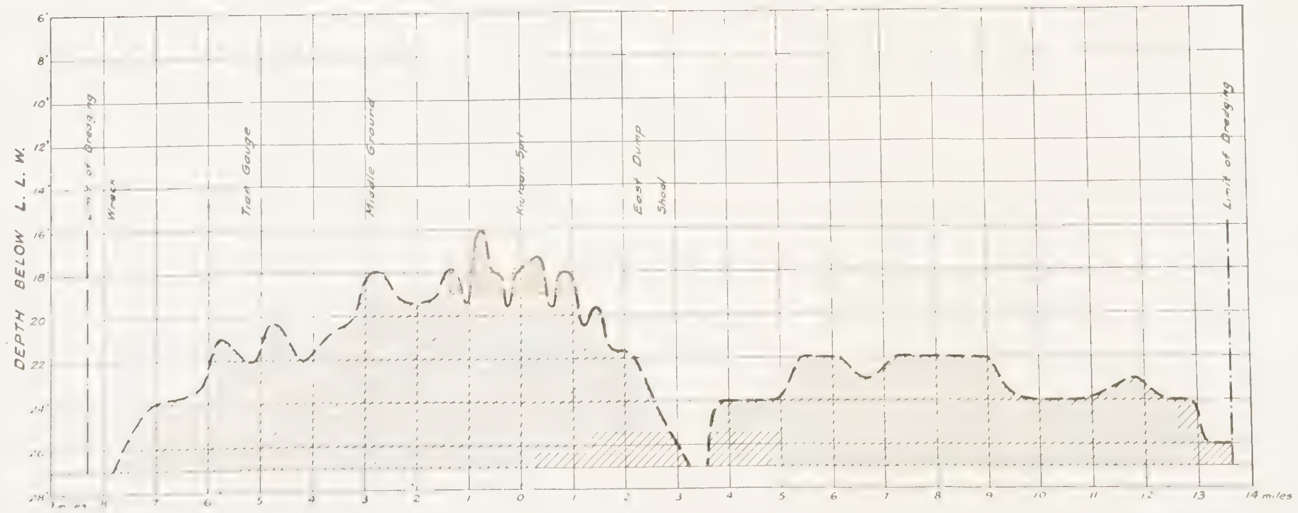
REVISED LOCATION OF INITIAL DREDGING ON THE YANGTSE BAR 1935-6

SURVEY OF 1935

SCALES AS SHOWN



LEGEND		圖例
L. L. W.	░░░░░░	最低水線
6-foot contour	··········	六尺水線
12 " "	·· ·· ·· ··	十二尺水線
18 " "	··· ··· ···	十八尺水線
24 " "	···· ···· ····	廿四尺水線
27 " "	····■ ····■	廿七尺水線
30 " "	····· ·····	三十尺水線



PROFILE OF YANGTSE BAR

神灘剖面圖

Pressboard
Pamphlet
Binder
Gaylord Bros.Inc.
Makers
Syracuse, N. Y
PAT JAN. 21, 1908

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